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POWER

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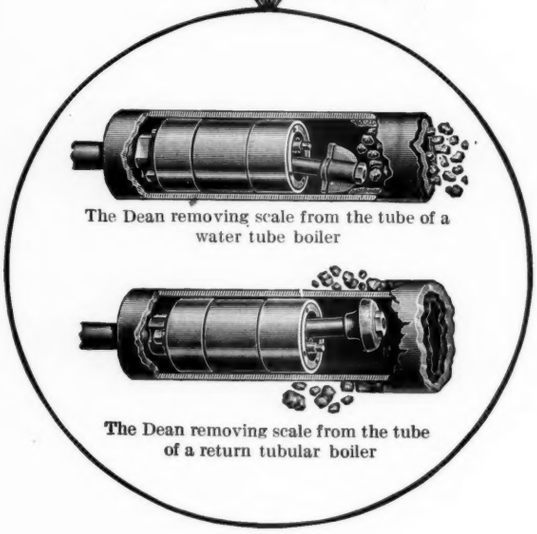

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POWER

NEW YORK, FEBRUARY 21, 1911

RECENTLY, a prominent engineer remarked that most people know less about their own business than is known by some outsider.

While this may be putting it rather too broadly, the remark, nevertheless, contains a grain of truth.

The operating engineer, being constantly on the spot, should know his plant better than anyone else.

This does not imply merely a physical knowledge of the plant equipment, such as a knowledge of the function of every valve, etc., but, in addition, all phases of operation, and then some.

Yet, many engineers become so absorbed in their daily routine work that they lose sight of the high points, only to awaken to the sudden realization that some outsider has seen the opportunity and is making capital out of it.

This accounts for the increasing business of the consulting engineer, the lubrication expert and the economic engineer.

Although the present is often referred to as an age of specialists, they should be employed only when necessary.

Undoubtedly, these specialists are able to materially decrease the operating expenses of many plants. In fact, in certain cases the available data at their command and their particular training makes their employment essential. But in the majority of cases a competent operating engineer could carry out the work just as well.

This applies to the more simple forms of construction and erection, as well as innovations in operation. If a new engine, boilers or auxiliaries are to be installed, there is no reason why the chief engineer of the plant, aided by the data and blueprints furnished by the manufacturers, should not be able to cope with the problem without an appeal to outside aid.

This, on the one hand, would save the owner considerable expense in fees to the expert; and, on the other hand, would not only increase the engineer's field of usefulness, but would also save his pride from being sacrificed by the intrusion of an outsider.

To be properly equipped for such work an engineer must be conversant with up-to-date practice. He must know what it should cost to produce a kilowatt-hour in such a plant as the one he is operating. He should be able to judge the quality of the supplies and should know their cost. It is important that he cultivate the habit of *observing*, not merely seeing; and, while keeping a keen eye to the small things about the plant at the same time, he must not become lost among the details. In other words, he must occasionally break away from the regular routine work and view the plant as an outsider through a binocular.

These characteristics, combined with the ability to successfully and systematically carry out a definite purpose, will fortify the engineer against encroachments upon his vocation.

Power Plant of a Newspaper Building

By Osborn Monnett

The interesting features of this installation are the water supply system, the arrangement of pumps and the hydraulic elevator piping. In connection with the latter, advantage was taken of the fact that in this service the load is always on the down trips, and the energy thus developed is utilized to raise the empty elevator.

About two years ago the entire printing establishment of the Cleveland *Plain Dealer* was destroyed by fire and in its place has been erected one of the most complete and uptodate newspaper-publishing establishments in the Middle West.

The power plant is in a well lighted corner of the basement with a 100-ton coal-storage bin conveniently located under the sidewalk. Coal is wheeled from the bin in a one-ton car, and is weighed on a Hunt scale before reaching the boilers. Two 150-horsepower Stirling boilers, equipped with Detroit stokers, furnish steam to three American-Ball engines direct connected to generators of 50, 75 and 125 kilowatts respective capacities.

The water-supply system is especially complete for a plant of this size and is arranged to operate with high-pressure lines to the upper floors and low-pressure to the first floor and basement, the water flowing by gravity from a storage tank supplied from the city mains. A plan of the system is shown in Fig. 2 and the operation is as follows: Water flows from the city mains directly to the storage tank, in which the level is maintained by a float valve. From this tank it flows to the house pumps and is pumped into tanks in which a pressure of about 40 pounds is automatically maintained by the action of the pressure regulators on the line. There is, however, a fluctuation of 20 pounds or more in the city-water supply, and should this pressure at any time exceed that maintained in the tanks, the water would flow directly to the tanks through the bypass and check valve *K*, in which case all floors would be supplied directly from the city mains. When the city pressure decreases below that maintained in the tanks, the pumps begin to operate; the discharge is prevented from returning to the city main by the check valve in the bypass. This arrangement automatically takes advantage of periods of high pressure in the city mains and thereby saves steam, which would otherwise be used in the house pumps during these periods.

Another notable feature of this plant is the pumping equipment. Vertical Cameron pumps are used and are mounted on the engine-room wall, each one on a handsome polished brass panel, as shown in Fig. 4. By this method a large pumping capacity is installed with the minimum of floor space and the pumps are easily accessible for inspection.

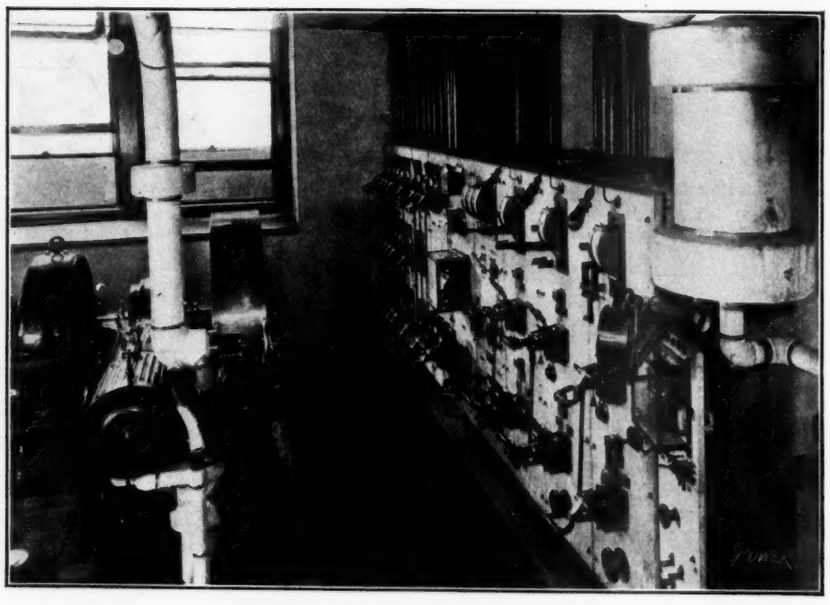


FIG. 1. SWITCHBOARD AND ENGINE

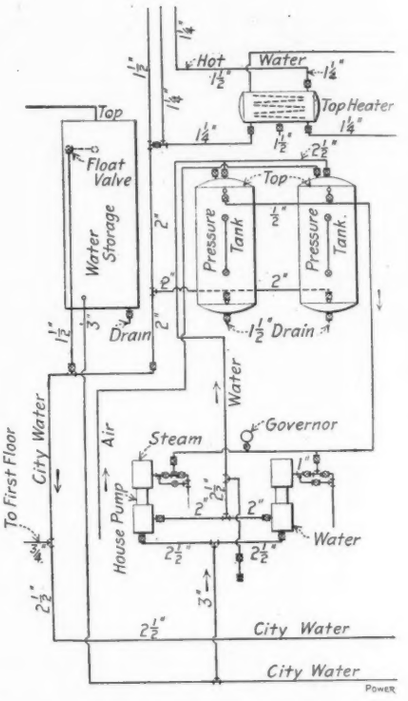


FIG. 2. WATER SYSTEM FOR HOUSE SERVICE

The piping layout for a hydraulic elevator used in the printing establishment is rather unusual. This elevator is employed in bringing rolls of paper from the store room to the press room and conditions are such that the load is always carried on the down trips, and the elevator goes up empty. Advantage has been taken of this circumstance to raise the elevator through the energy developed by the load in coming down; the way in which this is accomplished is shown

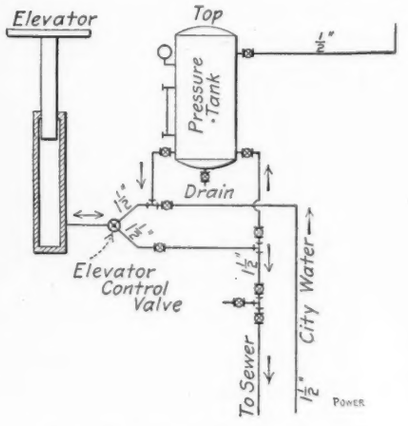


FIG. 3. HYDRAULIC ELEVATOR SYSTEM

in Fig. 3. During its downward travel the elevator discharges into a pressure tank partly filled with water, and this accumulated pressure is utilized to raise the empty elevator. A three-way control valve is placed so that, if desired, the elevator can be worked directly from the city-water mains in the ordinary manner, the water discharging to the sewer in this case.

The electrical distribution is on the 230-volt, three-wire system, with balancer sets supplying lighting current at 115 volts. The switchboard, which is shown in Fig. 1, contains no switches, except for the instruments, their place being taken by circuit-breakers.

Every machine in the establishment is direct-driven by motors, ranging in size from one-quarter to 60 horsepower, and the load on the plant for lighting and power is continuous, a 24-hour service being maintained. H. J. Graham is the chief engineer in charge of the plant.

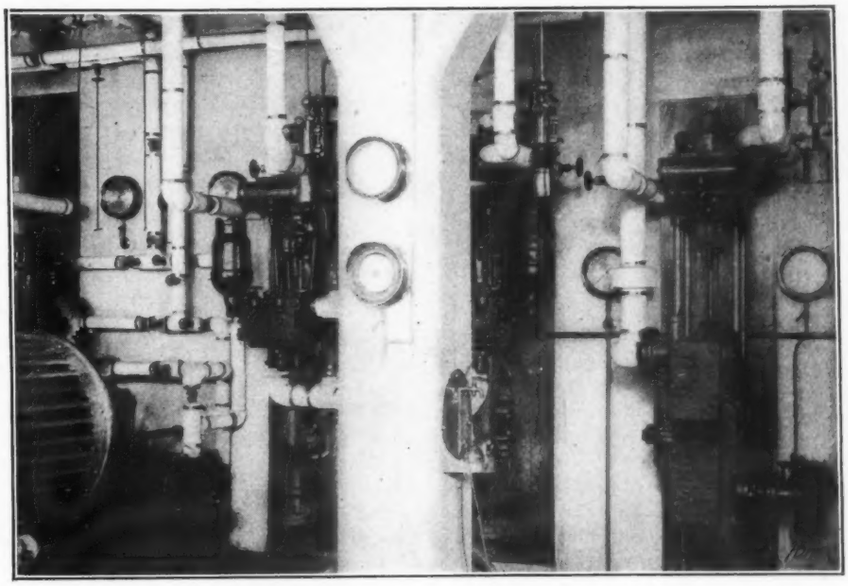


FIG. 4. PUMPS MOUNTED ON WALL

Piping for Central Station Heating*

By B. T. Gifford

General remarks on the manner in which the probable quantity of heating is ascertained. Method of laying out pipe lines and determining the pipe sizes.

*Abstract of paper presented before the American Society of Heating and Ventilating Engineers.

In the design of a central-station heating plant two things must be definitely determined: the location of the central station and the amount and location of the business to be served.

A method which the writer has used for some time with satisfactory results is as follows: First, prepare a map of the city drawn to scale, and of a size convenient to carry in the field; sometimes it is necessary to divide the map into two or more parts. Show on this map all streets and alleys, and the relative elevation of each street intersection. Note also the paved streets and the kind of pavement. Show also each building and mark the kind of building, whether for business, church, residence, bank, hotel or other purposes, together with the number of feet of radiation that will be required to heat it. After this information has been secured, make a survey and a careful study of the different sections of the city, noting on the map the best sections for the central heating plant to serve, taking into consideration at all times the future growth of the city. It is in this part of the design that experience is needed, and many times the engineer will find that he has made a poor guess. The word guess is used because in many cases central heating plants have grown beyond the wildest dreams of their designers.

In a good residential section where the houses are owned by people of moderate wealth, 90 per cent. of the possible business will be connected within five years. Any vacant lots in such a section should be considered as built upon with a building to compare favorably with the surrounding buildings.

In a business section 60 to 70 per cent. of the available business will be connected within five years. This is greatly dependent upon the kind of heat to be sold, whether steam or water, and whether the buildings are already equipped for heating with steam or water. As a rule, steam service is more popular in business sections, while in residential sections water seems to be more desirable.

The rapidity with which business is acquired depends upon the management, but the designer should anticipate a rapid growth in the number of consumers and the amount of business. After having determined the location and the amount of business possible and the central-station location, work on the details can be started.

Commence by laying in the lines on the map, in such a way as to reach the greatest amount of business with the least number of feet of pipe line. This requires oftentimes cut-and-try methods. Whether to use alleys or streets depends upon two things: First, the relative cost of street and alley construction; second, the location of the buildings relative to the street or alley. The writer has found that alley construction, other things being equal, will cost 15 to 30 per cent. more for the labor, owing to the difficulty of working in narrow places. Another thing affecting the cost of construction is the pavement, which has to be taken up and relaid.

In most cities the heating companies are obliged to bring their service pipes to the curb line in the street, and to the property line in the alleys. This item of expense should not be overlooked, for in a wide street the extra cost for service lines will more than eat up the saving in labor effected by street construction.

Assume for calculation a good residence section, as shown in Fig. 1, block 2. It can be assumed that 90 per cent. of the available business on this block, which is approximately 11,000 square feet of water-radiation, or approximately 6600 square feet of steam-radiation surface, will be secured.

It is necessary to allow for future extensions for block No. 1, and possibly more yet, but in this layout it will be assumed that eventually block No. 1 will equal block No. 2. Block No. 2 is 400 feet long, and block No. 3 is of the same length. There is, then, altogether 22,000 square feet of water radiation to be handled, but some of it will be taken off in the first 100 feet, and about 25 per cent. of it will be served by the time the center of block No. 2 is reached; 25 per cent. more will be taken off by the time B street is reached, and 25 per cent. when the center of block No. 1 is reached.

The writer has found it better practice

to throw most of the line friction into the trunk line and to have the friction loss in the laterals very small, and to make the friction loss in the laterals in proportion to the circulating pressure (difference in pressure) at the point at which the lateral begins. As an example, assume that at the point the lateral for

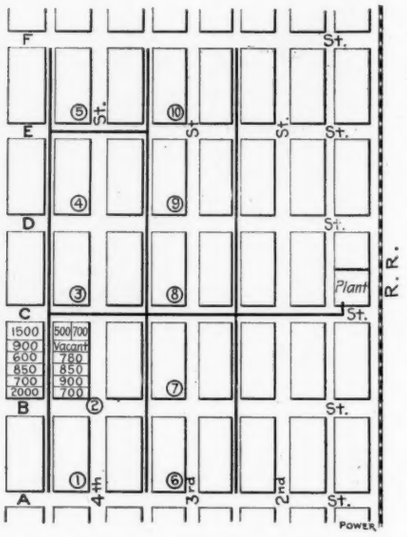


FIG. 1. PLAN OF AREA TO BE HEATED

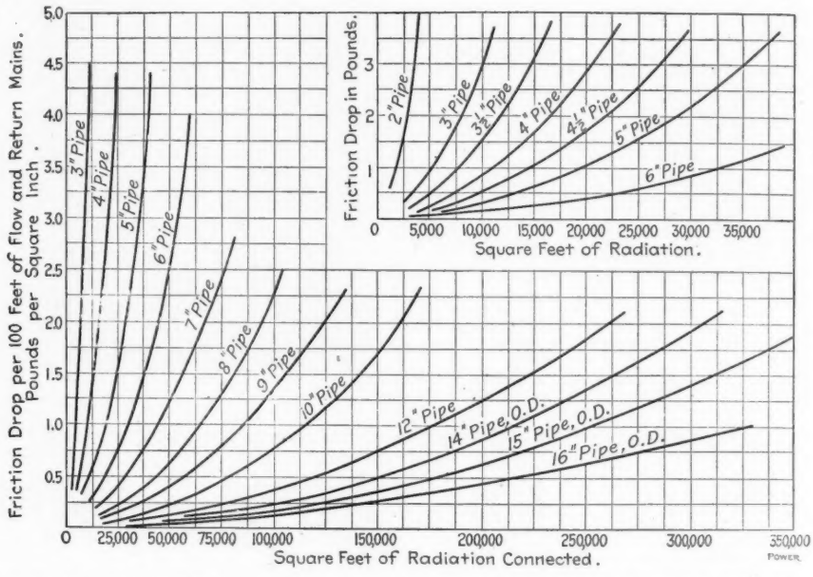


FIG. 2. DIAGRAMS OF PRESSURE DROP DUE TO FRICTION IN HOT-WATER HEATING MAINS

blocks Nos. 1 and 2 tap off the circulating pressure is five pounds. Now, there must be at least one pound of circulating pressure at the end of the lateral; therefore, four pounds can be lost in friction between the ends of the lateral, or one pound per 200 feet, which is five-tenths of a pound per 100 feet. Following are the conditions:

First 200 feet of line must handle 22,000 square feet of radiation.
Second 200 feet of line must handle 16,500 square feet of radiation.
Third 200 feet of line must handle 11,000 square feet of radiation.
Fourth 200 feet of line must handle 5500 square feet of radiation.

From the curves in Fig. 2 it will be seen that a 6-inch pipe will handle 22,000 square feet with this friction loss, and a 5-inch will handle 16,500 square feet, a 4½-inch will handle 11,000 square feet with a ½-pound loss, and a 3½-inch pipe will handle 5500 square feet of radiation with this friction loss.

A rule which the writer has followed is never to run a smaller water main than 3 inches in the initial layout; this will always allow for some future extensions.

In figuring a branch line off of a lateral, consider the circulating pressure at the point the branch leaves the lateral, as the originating pressure and one pound as the circulating pressure at the end of the branch.

The writer advocates the use of pipe bends instead of elbows or fittings in the lateral lines.

It has been the practice of some engineers to run a larger return line than flow line; for instance, a 3-inch flow and a 4-inch return line. This method, it is claimed, gives a more equal circulating pressure all over the system. The writer has found that by limiting the heavy friction loss to the main trunk lines, this objection is equally well overcome and the investment is slightly reduced.

PIPE-LINE DESIGN FOR STEAM HEATING

In designing a central-station steam-pipe line the same general plan is used. In this case, however, the friction loss is dependent upon the maximum back pressure allowed on the engines if connected as a byproduct system. A live-steam central heating plant should be designed along the same general plan as a hot-water heating system, with 25 pounds as the maximum pressure on the pipe line. The curves in Fig. 3 show the steam-pipe capacities.

Assuming the same territory, viz., blocks Nos. 1 and 2, the following calculations would determine the steam-heating pipe sizes. In this case it will also be assumed that the original pressure where the line begins is three pounds. There will be required at least one pound pressure at the end of the line; therefore, two pounds can be lost in friction. This allows 0.25 of a pound per 100 feet of pipe. Following are the conditions for a steam-heating system:

First 200 feet of line must handle 13,200 square feet of radiation.
Second 200 feet of line must handle 9900 square feet of radiation.
Third 200 feet of line must handle 6600 square feet of radiation.
Fourth 200 feet of line must handle 3300 square feet of radiation.

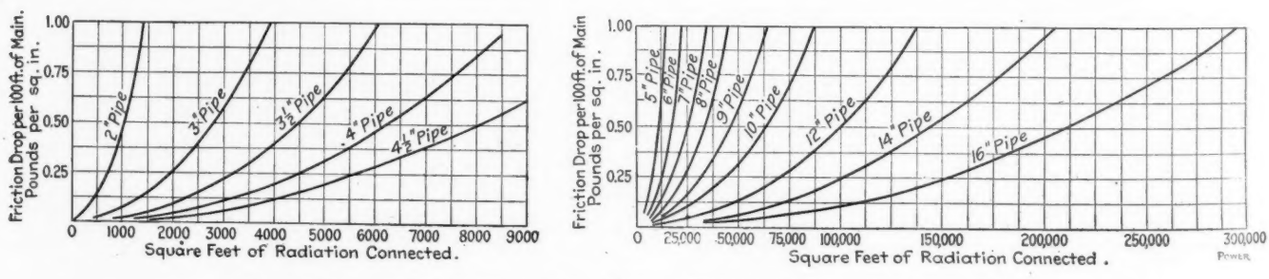


FIG. 3. DIAGRAMS OF PRESSURE DROP DUE TO FRICTION IN STEAM-HEATING MAINS

From the curves in Fig. 3 the pipe sizes may be ascertained in the same manner as in the previous example on hot-water heating.

As in the case of the hot-water heating system, there should be a minimum size of pipe to install as a main and in steam heating the writer has fixed upon 4 inches as the minimum.

Efficiency of Live Steam Feed Heater

By Prof. A. H. Gibson

Use of heater with locomotive boiler raised efficiency 1.08 per cent. Gain attributed to higher rate of heat transmission due to a lower temperature of the plate in the vicinity of the feed inlet.

In view of the diversity of opinion among engineers as to whether the addition of a live-steam feed heater to a steam boiler may in any case lead to increased efficiency of working, the author recently decided to carry out a series of trials to test the effect of such a heater on the steam boiler forming part of the laboratory equipment of University College, Dundee, Scotland.

This boiler is specially equipped for testing; all measurements of fuel burnt, of water evaporated and of temperatures can be made with great accuracy. The steam produced was used for driving a brake-loaded experimental engine whose load could be maintained constant or varied as required from test to test.

The boiler was of the locomotive type with an internal diameter of 3 feet 6 inches; and contains 47 tubes, 3 inches in diameter and 6 feet 10 inches long. It has an effective grate area of 7.5 square feet, with a heating surface of 315 square feet, and its general arrangement is shown in Fig. 1.

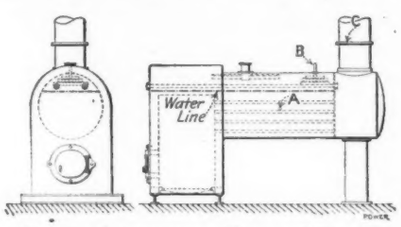


FIG. 1. LOCOMOTIVE TYPE OF BOILER

The feed water is supplied by a force pump worked from the crosshead of the main engine. When supplied to the boiler cold it enters through an opening in the side of the boiler, as shown at *A* in Fig. 1.

When the live-steam feed heater is in use the cold feed enters at the top of the boiler, at *B*, Fig. 1, and passes through the heater before finally escaping into the water space of the boiler. The heater, Fig. 2, was constructed specially for the tests, and consists simply of three shallow tin-plate dishes superposed and connected to each other by distance pieces. The feed water admitted by the feed pipe to the bottom of the upper dish overflows into the second. A central overflow pipe maintains a constant depth of about 5/8 inch in this dish, and overflow takes place through this pipe into the bottom dish, from which it overflows and drops into the water space of the boiler. The heater was supported in the steam space of the boiler on two convenient longitudinal stays. It was made as large as could be conveniently got into the very constricted space available, but could with advantage have been made larger, the feed water not remaining in contact with the steam for a sufficiently long interval of time to enable it to attain full boiler temperature before mixing with the water in circulation.

The temperature immediately before overflow was measured by means of a mercury thermometer in a pocket situated as shown in Fig. 2.

The boiler is operated under natural chimney draft regulated by a damper at the outlet from the smoke box, and in order to insure a thorough mixing of the hot gases before taking their temperature, this was measured, by means of a platinum-iridium thermocouple, at the center of the outlet flue at *C*, Fig. 1.

Four tests were carried out, those on Wednesday and Thursday, December 7 and 8, 1910, having the heater in operation, but with very different loads on the boiler, and those on Wednesday and Thursday of the following week without the heater, but with rates of evaporation similar to those in the two preceding runs. In each case the boiler was under steam on the Tuesday, while on the days of the trials the actual test did not commence until the plant had been running under normal conditions sufficiently long for a steady state of affairs to be obtained.

From results obtained in the tests it was figured that the relative gain in efficiency by use of the heater was 1.08 per cent. for light loads and 1.083 per cent. for heavy loads. Some of the more important deductions from the tests are given in the accompanying table.

DEDUCTIONS MADE FROM TESTS.

	Light Load.		Heavy Load.	
	With Heater.	Without Heater.	With Heater.	Without Heater.
Heat transmitted per square foot of heating surface per hour—B.t.u.	1970	2255	4220	4090
Weight of fuel fired per square foot of grate per hour, lb.	10.35	13.20	24.52	26.50
Weight of dry fuel per square foot of grate per hour, lb.	9.39	11.57	21.75	23.60
Water evaporated per pound of fuel as fired, lb	6.85	6.14	5.84	5.56
Water evaporated per pound of dry fuel, lb.	7.56	7.01	6.595	6.25
Equivalent evaporation from and at 212 deg. F. per pound of dry fuel, lb	9.15	8.46	7.975	7.54
Weight of feed from and at 212 deg. F. per square feet of heating surface per hour, lb.	2.04	2.33	4.13	4.23

REASONS FOR INCREASED EFFICIENCY

With a view to throwing some light on the reason why such a method of feed heating should lead to more economical working, a series of experiments were afterward carried out on an open cast-iron vessel about 8 inches in diameter and containing about 3 inches of water. This was heated up by means of a ring of gas jets giving a flame whose mean temperature was 2000 degrees Fahrenheit. The temperature of the water side of the plate was measured by means of a platinum-iridium thermocouple placed in intimate contact with the plate, a shallow depression, 1/64 inch in diameter, being made in the plate to receive the point of the couple. The temperature of the water was taken by means of a mercury thermometer, and the results of the experiments are as follows:

Temperature of water, degrees Fahrenheit...	120	140	160	180	212
Temperature of plate, degrees Fahrenheit..	190	208	215	220	212.5
Difference, degrees Fahrenheit.....	70	68	55	40	0.5

In these experiments the water was stirred vigorously during the whole period of heating, and they do confirm what has been pointed out by previous experimenters that, under given conditions of heat transmission, the difference between the temperature of the water and of the water side of such a plate is very much greater when the water is being heated up to boiling point than when it is in ebullition, and this, although the water is circulating vigorously over the hot surface.

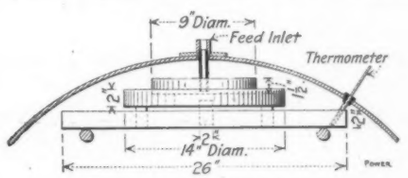


FIG. 2. PRIMARY HEATER

In these experiments, too, however great the ebullition, it was found impossible to increase the temperature of the water side of the plate to more than 213 degrees Fahrenheit, and in the great majority of cases the temperature was, as nearly as could be measured, identical with that of the water.

As a result of these experiments it

would appear reasonable to assume that over the tubes, in the neighborhood of the feed inlet to a boiler, the temperature of the water side of the plate, and, therefore, of the fire side of the plate for a given rate of heat transmission, would be appreciably lower—possibly as much as 40 degrees Fahrenheit lower, and probably at least 20 degrees Fahrenheit lower—with the heater in operation than without it. At first sight it would appear that such a small difference is totally inadequate to account for any appreciable difference in heat transmission and hence in the efficiency, for since the temperature of the gases has a mean value of probably 1200 degrees Fahrenheit, the mean difference between the temperature of the gases and that of the tube surface will be about 850 degrees Fahrenheit, and a difference of 20 degrees Fahrenheit in this, assuming heat transmission to vary as difference of temperature, would only affect heat transmission by a little over 2 per cent. Assuming the heat transmission from gas to plate to vary as the square of the temperature difference, this would increase the effect to, roughly, 5 per cent.

Even though the great proportion of the heat is transmitted by conduction from gas to metal, it appears, however, that a cooling of the metal surface is likely to be much more effective than a corresponding increase in the temperature of the hot gases. As is well known, transmission of heat by conduction from stratum to stratum of a hot gas is a mass phenomenon, and depends on the velocity (therefore greatest near the center of a tube where velocities are greatest), on the difference of temperature, and increases directly as the density. Owing to the rapidity of the motion, heat is readily transmitted from the central filaments in such a tube to those nearer the walls, but with considerable less ease in the immediate neighborhood of the walls where the motion is comparatively sluggish. In the neighborhood of the walls, however, the gas is cooled down to a temperature approximating much more nearly to that of the cool surface; its density is considerably greater than in the center of the tube, and is greater as the tube surface is cooler, so that any cooling of this surface has a double effect in increasing the rate of transmission.

On the whole it would appear that these differences in the rates of heat transmission, though severally small, when acting cumulatively offer a possible explanation of the gain in efficiency undoubtedly obtained in the present series of tests by the use of the live-steam feed heater.

The reason for the greater gains in efficiency, in the case of the more heavily worked boiler, is probably due to a greater portion of the heating surface being occupied in heating up feed water rather than in the process of evaporation, in such a boiler, than in one more lightly worked. With feed water at 40 degrees Fahrenheit over 25 per cent. of its total heat is given to the water during this process of heating up, and the proportion of the whole heating surface affected by this must be roughly proportional to the weight of cold feed per minute. From this and other considerations it may be expected that such a heater will be found to be most effective:

1. In a given boiler when this is most heavily worked.
2. Where no economizer is fitted to take advantage of the heat rejected in the flue gases.
3. Where the boiler is fed with cold feed water.
4. Other things being equal, in a boiler in which the heating surfaces are somewhat incrusted.

Could Not Damage the Turbine

When a 1500-kilowatt Westinghouse steam turbine was loaded on a flat car at the company's works, ready for shipment to the Cia Minera Las Dos Estrallas mines at Tultenango Est de Mexico, there was every reason to believe that the shipment would reach its destination in good shape.

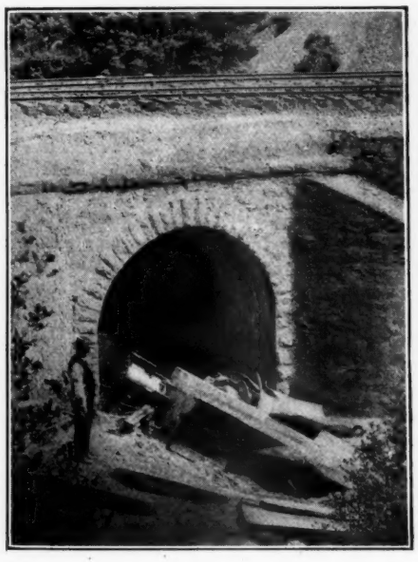


FIG. 1. SHOWING WHERE THE TURBINE LANDED

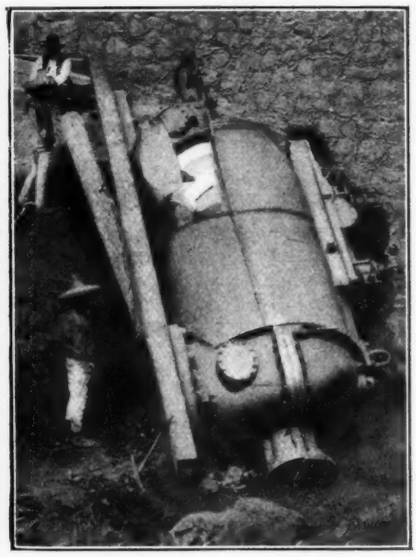


FIG. 2. BROKEN PLATFORM AND LAGGING

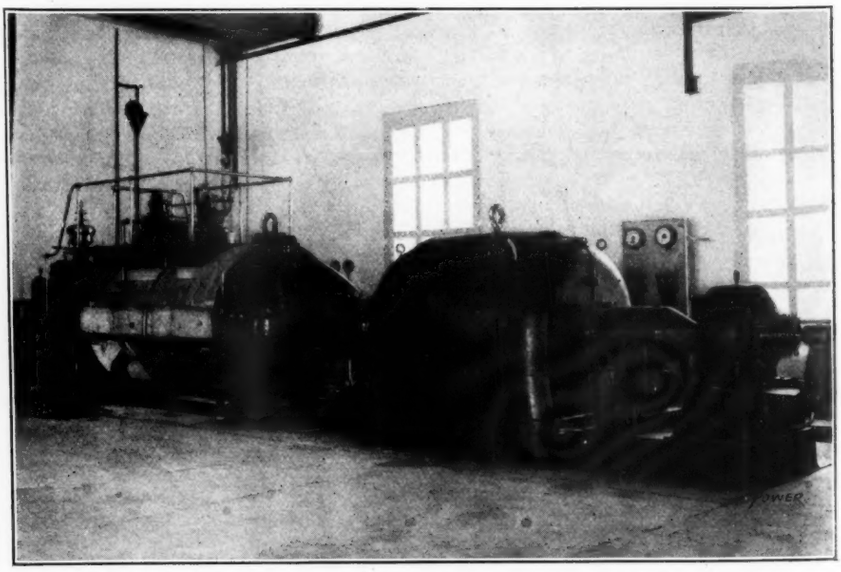


FIG. 3. TURBINE SET UP AND PUT IN OPERATION BEFORE ANY REPAIRS WERE MADE

Matters went well until the train reached a 20-foot embankment in which a stone bridge had been built. Just as the car on which the turbine was loaded reached this bridge the car collapsed and

the turbine took a drop of 20 feet, making one complete revolution in its descent and landing in the river bed, as shown in Figs. 1 and 2.

For three weeks the turbine lay where it fell, while a spur track was being built to it, as no tackle was available for hoisting the turbine onto a car on the main track. The turbine finally reached its destination, was set up and had been in operation for some time before the manufacturers were aware of the accident.

After a month's delay a man was sent from the factory, who took the turbine down and examined every part. No injury to the machine was found, with the exception of the breaking of the polished steel lagging and the upper platform, as shown in Fig. 2.

Fig. 3 shows a view of the turbine after it had been set up and before the lagging had been replaced.

There may be a prevailing idea among engineers that the general run of steam plants in Mexico are of ancient design. There are, however, many modern steam installations, and the plant in which this particular turbine is installed is uptodate in every particular. The turbine is rated at 1500 kilowatts and is run condensing. Steam pressure at 150 pounds gage is carried and the boiler-room equipment is every bit as modern as that in the engine room.

Capacity of Refrigerating Plant

How much refrigeration will be required to cool a cold-storage compartment, 8x9x10 feet high, to a temperature of 35 degrees, and cool 1000 pounds of butter through 20 degrees every 24 hours. The cooler walls consist of two layers of tongue and groove sheathing with paper between, a 4-inch air space, two more layers of sheathing with paper, a second 4-inch air space and finally a third pair of layers of sheathing with paper between. Will a single-cylinder single-acting ammonia compressor operating at 70 revolutions per minute about six hours per day do the required work.

Which is the best, an open or inclosed type, vertical or horizontal compressor?

How much direct expansion piping will be required?

How much condenser surface?

The heat transmission through insulation of the above construction has been given, in a series of values of different types of insulation published by the Armstrong Cork Company, as 3.43 B.t.u. per square foot per degree difference in temperature inside and outside for 24 hours. The superficial surface of a cooler of the above dimensions is 484 square feet, the maximum difference in temperature is

$$90 - 35 = 55 \text{ degrees}$$

from which the total heat transmission is found to be

$$3.43 \times 484 \times 55 = 91{,}770 \text{ B.t.u.}$$

or

$$91{,}770 \div 144 = 637 \text{ pounds}$$

per 24 hours.

The cooling of 1000 pounds of butter through 20 degrees Fahrenheit requires

$$1000 \times 20 \times 0.5 = 10{,}000 \text{ B.t.u.}$$

or 69.4 pounds per 24 hours, making a total duty of 706.4 pounds, or 0.353 ton.

A 5x5-inch single-cylinder single-acting compressor operating at 70 revolutions per minute when producing temperatures around 36 degrees, should develop a capacity of 0.64 ton per 24 hours and would consume approximately 1⅓ horsepower.

To operate only six hours per day the compressor would have to be increased in proportion to the reduced operating time. The required cooling effect, as determined above, is 0.353 ton per 24 hours. If the work is to be done in twelve hours, the capacity of the machine must be twice as great, or 0.706 ton, and if in six hours, four times as great, or 1.4 tons. Since the capacity of the compressor operating at 70 revolutions per minute was found to be only 0.64 ton per 24 hours, the speed of the compressor will have to be increased in the ratio,

$$0.64 : 1.4 :: 70 : S$$

which gives for S, the required speed, 153 revolutions per minute. The horsepower will have been increased in proportion to the speed, or,

$$70 : 153 :: 1.33 : H.P.,$$

which gives $H.P.$, the required horsepower to perform the cooling work in six hours, as 2.9 horsepower.

If possible to do so, it would be much better to operate the compressor in question twelve hours per day, in which case about 75 revolutions per minute would be a sufficiently high speed, and only about 1½ horsepower would be consumed.

It would not be safe to use less than a three-horsepower motor for operating the machine as single-acting machines and especially single-cylinder single-acting ones require a considerable initial starting power over that required to drive the machine under the conditions of normal operation.

Double-cylinder machines, while somewhat more expensive to build, are much more satisfactory in this respect than single-acting ones, and they possess the additional advantage of having half their capacity available in case of a broken suction or discharge valve on one of the cylinders. Operating one side of the machine above its normal speed longer than its usual time of operation may save the stored products, while repairs for the other are being procured.

As regards the relative merits of open and inclosed crank-case types of compressor, each has advantages over the other. The inclosed crank-case machine, which is also a vertical machine, would in all probability be found most satisfactory for the limited requirements. Packing against ammonia pressure in this type of machine is made on the rotating crank shaft instead of on a reciprocating piston rod as in other types. It is much easier to keep the former packing tight, especially where the machine is not to be operated continuously.

It would be good practice to use a compressor with the suction valve located in the piston head, as the effect of inertia at the lower end of the stroke causes the prompt closing of the valve, thereby preventing any undue opportunity for gas that has entered the cylinder, to escape without being compressed. Similarly, inertia tends to open the valve as the piston begins its downward stroke, thereby giving full opportunity to fill the cylinder during the whole of the downward stroke.

If the machine is to be operated only six hours per day at 27 pounds back pressure, on which the capacities previously given were calculated, about 6400 running feet of 1¼-inch direct-expansion piping should be used. If the machine is to be operated twice as long, the piping can be reduced, but not in the same ratio; 3500 to 4000 running feet being required.

If cooling water at the usual temperatures is available and the condenser is to be of the double-pipe type in which the cooling water passes through the inner pipe and the ammonia gas between the inner and the outer pipes, about 20 running feet per ton is a good ratio, or for the above machine operating six hours per day, about 28 feet. If it is to operate twelve hours, about 20 feet would be ample so far as the actual work to be done is concerned. It is customary, however, to put in condensing and expansion surface equal to the entire capacity of the machine as first indicated.

The *Manchester* (England) *Union* is sponsor for the following addition to the gaiety of the nation:

"The story is told of the times of Aretas Blood and the old Manchester Locomotive Works, that a student came to Mr. Blood once and wanted to study the business of locomotive building in his vacation days. The student came well recommended, and Mr. Blood, who never had much use for these 'tech' people, sent him down to the boiler shop and placed him in charge of the old foreman. The old man took the 'tech' man around, and in the course of the inspection of the shop they came across one boiler on the inside of which was a man at work.

"'How does that man get out?' inquired the 'tech' man.

"'Oh,' said the venerable pilot, 'he doesn't get out. We always count upon losing at least one man in building a boiler.'"

Low Pressure Turbine in Davenport

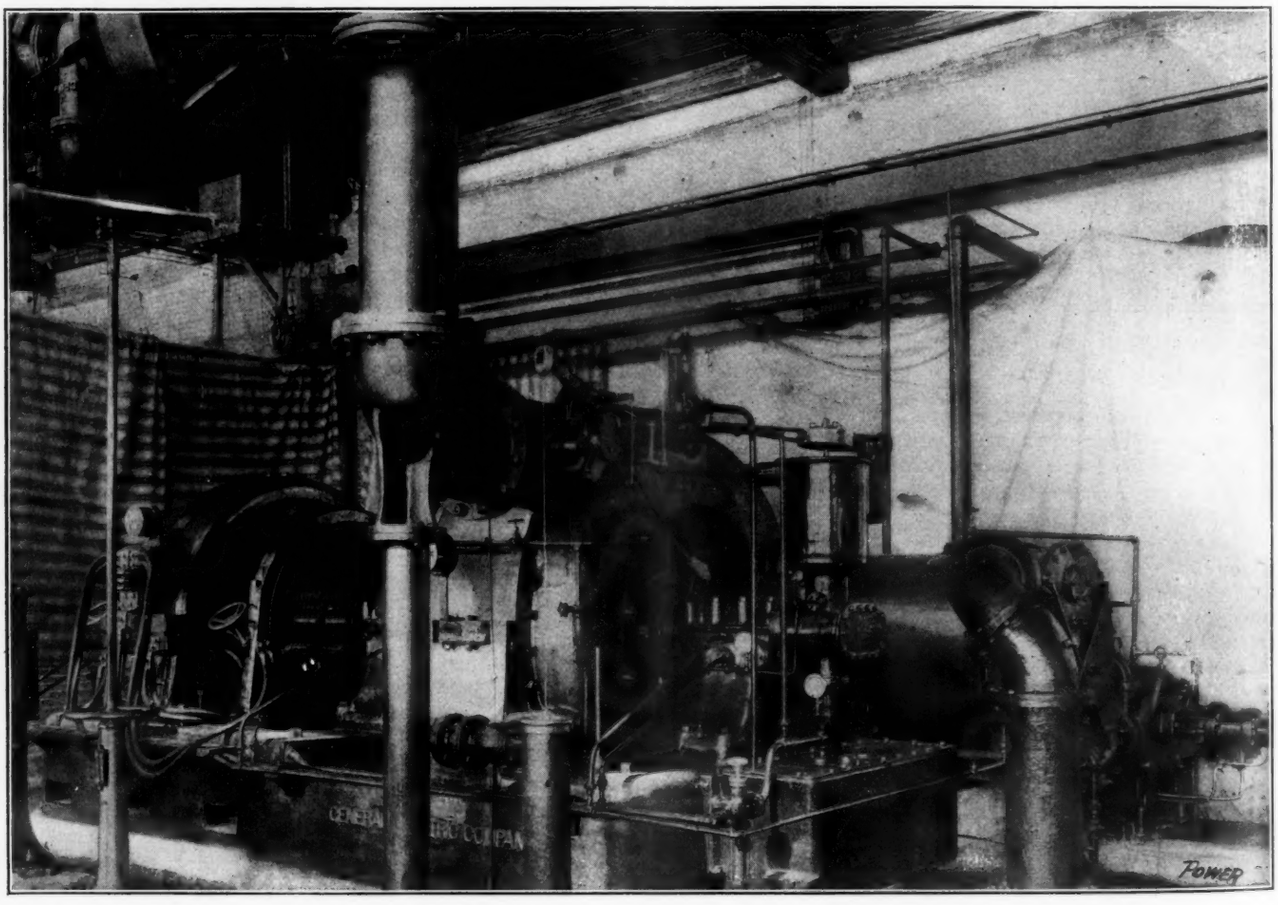
By P. Bendixen

A 500-kilowatt unit takes exhaust steam from engines, pumps and air compressor and develops about three-fourths of the energy delivered to the primary units.

About two years ago the Bettendorf Axle Company, of Davenport, Ia., was considering an addition to its electrical equipment, due to the growth of the plant, and made a thorough investigation of the various prime movers suitable for the purpose. Taking into consideration the heating of the shops in winter and the fact that the old power plant was running noncondensing, all factors pointed to the low-pressure or exhaust turbine as the most suitable power unit to install, from the standpoint of reliability, simplicity, economy and maintenance.

The power equipment at that time consisted of two 100-kilowatt direct-connected high-speed tandem-compound engine-driven units, a number of hydraulic pumps and an air compressor exhausting into one header, making an ideal arrangement for connection to an exhaust turbine. The company decided to install a 500-kilowatt horizontal Curtis turbine. This turbine was put in operation in September, 1909, and has been in service for about 14 hours per day since. It supplies all electrical power required by the plant, which at present amounts to 250 kilowatts average load, this power being used mostly for the operation of cranes, the lighting of shops, and for lifting magnets. When machinery now under construction is completed and installed, the load will be increased to about double. The main steam supply is derived from the exhaust of the hydraulic pumps, but, owing to the fact that these pumps are subject to interrupted service, due to breakdowns on the system, other means of supplying steam had to be provided and a connection was therefore made from the exhaust header to the high-pressure steam pipe through a 4x8-inch Foster pressure-reducing valve. By means of this connection the required amount of steam to keep the turbine in operation is secured. This arrangement works very satisfactorily, as the valve operates within a range of one-half pound drop in pressure. The average back pressure is about three pounds, and to take care of an excessive back pressure the exhaust header is provided with a 12-inch relief valve set to operate at five pounds pressure. All steam to the turbine passes through an 18-inch two-stage separator, which separates all oil and moisture from the steam. A Worthington condenser with 3150 square feet of surface is installed, the condensed steam being returned to the boiler feed-water heater.

While no figures are available to substantiate a statement as to the exact performance of the turbine, it is thought possible, when running with 28-inch vacuum, to recover 75 per cent. of the energy delivered to the pumps, compressors and reciprocating engines. In cool weather it has been possible to run for weeks with a vacuum of from 29 to 29½ inches, this, of course, making quite a difference in the steam consumption. In order to maintain a good vacuum, it has been



Low-pressure Turbine Installation in Plant of the Bettendorf Axle Company

found necessary to pipe the steam seal in which the carbon-packing rings are located with high-pressure steam to insure against any leakage of air around the shaft. The amount of steam required for this purpose can best be found by experiment, and when once adjusted requires very little attention.

Before putting the turbine in service it was run for a few days under various loads, the generator being loaded on a water box. It was found that sufficient exhaust steam was available to furnish 425 kilowatts continuously, and as much as 575 kilowatts for short periods. Six boilers of about 120 horsepower each were in service at that time. The results of the test would indicate that 75 to 80 per cent. of the energy delivered to the engines and auxiliaries was recovered.

With a load fluctuation of about 500 amperes, the variation in potential does not exceed two or three volts. The lighting load consists of inclosed-arc, flame-arc, mercury-vapor and incandescent lamps.

Good results are obtained without the use of a receiver generator between the units and the turbine, as the reducing valve makes up for any deficiency in the steam supply which might be due, as stated before, to the stoppage of one of the engines or pumps. With this arrangement a sufficient supply of steam is always assured.

The longest continuous run so far made with this turbine has been five days and nights. No shutdowns, due to trouble of any kind with the turbine, have occurred since the turbine was first put in operation, and this company can conscientiously recommend the installation of a low-pressure turbine in any place where a sufficient supply of exhaust steam is available for its operation.

Verdict in Pabst Explosion Case

Growing out of the boiler explosion described in Power, November 9, 1909, this interesting case has been decided in favor of the Pabst Company, a verdict of $97,400, with interest from December 1, 1909, being awarded. The case was immediately appealed.

The case of the Pabst Brewing Company versus the Hartford Steam Boiler Inspection and Insurance Company, growing out of the boiler explosion which occurred at the Pabst plant on the morning of October 25, 1909, has just been heard in Milwaukee before A. L. Sanborn, United States district judge for the western district of Wisconsin.

The Pabst Brewing Company sued on two counts, the first being that the Hartford company "represented and held itself out to the public as skilled and expert in the examination and inspection of steam boilers and that its inspectors would make the skilled and careful examinations necessary to determine the safety and condition of the exploded boilers and that the results of all inspections would be promptly and truly reported to the Pabst company so that the latter would be kept continuously and accurately informed as to the true condition and safety of said boilers."

The plaintiff alleged "on information and belief that on and prior to the fourth day of September, 1909, said boilers were not free from dangerous defects and were not in good condition, but that each of said boilers contained, among others, the divers and dangerous defects following: Checks, cracks and openings along, and in connection with, the reinforcing strip or plate of the drum of each of said boilers; defective, imperfect and broken rivets on each side of said reinforcing plate and elsewhere in each of the drums of said boilers, and other dangerous defects which this plaintiff is unable of its own knowledge or on its information and belief to particularly set forth and specify."

The plaintiff further alleged "that the boilers were in an unsafe and dangerous condition and said defects were of such a nature as to be obvious to anyone having any knowledge, skill and experience in the examination of steam boilers, and that the defendant ought, in the exercise of ordinary care and prudence and reasonable skill, to have discovered said defects and advised and informed the plaintiff thereof, prior to the explosion."

Also it was alleged "that the defendant was careless, reckless and negligent in making inspections; failed to observe and discover the dangerous defects, and wrongfully and negligently failed to inform the plaintiff as to the true condition of its boilers." "That by reason of said wrongful and negligent inspection the boilers were continued in operation and did explode on the 25th of October, 1909, and that by reason thereof the plaintiff was prevented from carrying on its business and suffered damage to the amount of $16,960.57."

For a second cause of action the plaintiff alleged "that the defendant contracted to insure against all loss, or damage, which might result from the explosion of any one, or all, of the six Munoz boilers contained in the boiler house which was damaged, not to exceed the sum of $150,000 and that three of these boilers did explode while the policy was in force, causing a property loss of $114,361.94."

It will be seen that the suit was first for the recovery on the ground of negligence, of $114,000 direct damage, subsequently reduced by conference to $97,400; and some thirty-odd thousand indirect damages; and, secondly, for the recovery under the contract for the direct damages only.

The question from the standpoint of the defense seemed to hang largely on the wording of the policy, in which there was a limiting clause covering damage due to any one explosion. The policy affected to insure the Pabst Brewing Company "for $150,000 against all immediate loss, or damage, except by fire, to the property specified in the policy, or resulting from loss of life or injury to persons caused by the explosion, collapse, or rupture, of any or all steam boilers covered by the policy." It further covenanted "that by the terms 'explosion, collapse or rupture' was to be understood a sudden substantial tearing asunder of the boiler or any portion thereof or the sudden crushing or forcing inward of the furnace or flues, etc." In a "rider" on the policy, however, it was further provided "that the total liability of the company from loss or damage from any one explosion should not exceed the sum of $50,000, and in case of more than one explosion the entire liability of the company should not exceed the sum insured by the policy, viz., $150,000."

Immediately following the explosion the Pabst company engaged a committee of four engineers, consisting of C. J. Davidson, R. D. Tomlinson, E. E. Adams and Owen P. Davies, to make an examination of the exploded boilers and report their opinion as to the probable cause of the disaster. In the testimony for the plaintiff the result of this investigation was brought out. All four of the investigators were unanimous in their belief that the initial rupture occurred along the center line of a reinforcing plate riveted to the drums of the boilers as in the regular construction for this make of boiler, and shown in the accompanying sketch. They testified to their belief that the presence of this strip of metal, which was 5/8 inch thick, riveted to the 3/8-inch drums, was, owing to the unequal expansion and contraction of the two pieces of metal, a serious menace to the life and safety of the boilers. The history of the boilers was brought out quite thoroughly during the prosecution of the case. It developed that excessive

leaking had been noticed along this reinforcing seam and that many rivets had become loose and been replaced in the effort to stop this leaking. Also the outside edge of the plate had been repeatedly calked with the same object in view. The examining committee had investigated the condition of Nos. 5 and 6 boilers, which did not explode, and testified to finding cracks easily visible between the row of rivets holding the reinforcing strip to the shell of these boilers, these cracks being attributed to the breathing action resulting from holding a portion of the boiler shell rigid under the reinforcing strip, allowing the remainder of the shell to expand and contract with the steam pressure, and also to the unequal expansion and contraction due to the different thickness of the two pieces of metal. It was contended by the plaintiff that, inasmuch as Nos. 5 and 6 boilers were found to be in this condition, it was reasonable to suppose the exploded boilers, being of the same age and having the same general treatment throughout their lives, were in the same weakened condition, making them dangerous for the working pressure carried in the plant.

In answering the charges, the defendant alleged "that in the event of an explosion of all, or any, of the boilers the total liability for all loss or damage resulting from any one action, or explosion, however caused, should not exceed the sum of $50,000. That said boilers and property mentioned were destroyed and injured by one accident or explosion within the meaning of the policy, and that by reason thereof the liability did not exceed the sum of $50,000; and that the explosion was caused by the neglect and carelessness of the plaintiff. That, in case of more than one accident occurring during the three-year period covered by the terms of the policy, the entire liability of the defendant should not exceed the sum of $150,000."

In opposition to the claim based upon negligence the defense, while denying any lack of diligence in this respect, maintain that, although the policy gave the defendant permission to make boiler inspections, still it was not bound to do so, and that what inspections were made were simply and solely for the information of the defendant itself, and that it was not obligatory that these reports should be given to the owner of the insured boilers. In all cases, however, it was contended that such information had been given after each inspection.

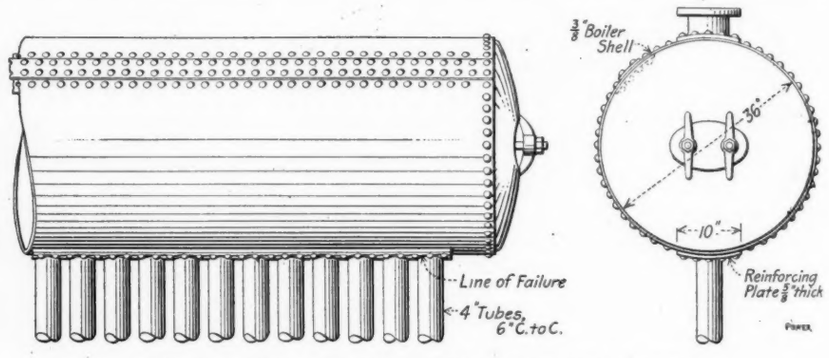
Answering the technical features of the case, B. J. Morrison, of St. Mary's, O., testified for the defense, that in his opinion the initial rupture came in the main steam line of the plant or some of its principal connections and that the water, flashing into steam, caused an overproduction of pressure which exploded the boilers. He also believed that the leaking around the reinforcing seam came from where the tubes were expanded into the drums. In his opinion the cracks between the rivet holes were caused by rolling the plates in process of manufacture and after the row of rivet holes had been punched.

These cracks, he believed, were entirely covered by the reinforcing strip in such position as to be impossible of detection when making boiler inspections. He admitted that it would be only a question of time until the drum would fail under these conditions, as there would be a breathing action along this row of rivets. In regard to the effect of differential expansion he believed that this could be set down as negligible, the movement, if any, being so absolutely small as not to warrant serious consideration. Mr. Morrison was of the opinion that none of the cracks between the rows of rivets in the reinforcing seam could have been visible before the explosion and believed that if six or more cracks had existed entirely throughout the sheet, between the rivet holes in the reinforcing seam, it would have been impossible to keep water in the boiler or maintain steam pressure. In answer to the contention that Nos. 5 and 6 boilers were found to have dangerous cracks in the shell along this reinforcing seam, he testified that in his opinion these cracks were not there before the explosion but were caused by the violent concussion of the explosion. Nos. 4 and 5 boilers, it developed, were connected to the line at the time the explosion occurred, while No. 6 was disconnected, and not under steam. He believed that the reason Nos. 4 and 5 did not explode was because Nos. 1, 2 and 3 happened to be the weaker, owing to the breathing action along the reinforcing seam, and that they were unable to stand the concussion brought about by failure in the steam line.

Prof. L. P. Breckenridge, of New Haven, Conn., also testified in the defense. It was his belief, according to the testimony, that the primary cause of the explosion had been a failure in the steam line or some of its principal connections and that the sudden release of pressure had created an instantaneous steam pressure higher than the drums could stand. He criticized severely the design of the boilers, testifying that he believed the drums were prevented from assuming a true circle, owing to the presence of the heavy reinforcing plate having a tendency to make this part of the drum rigid and flatter than the other points. This, he believed, contributed largely to the failure of the boilers, as during the entire life of the boilers there would have been a breathing action, setting up stresses along the length of the drums. He also criticized the boiler with respect to circulation, although he did not think that any of these points had a direct bearing on the cause of the explosion, and the fact that all the drums let go along the reinforcing strip showed merely that this was the weakest part of the boiler and that the failure would naturally occur at this point after being set off by the breakage of the steam line.

Regarding the cracks found in Nos. 5 and 6, he testified that in his opinion they were developed by the concussion when the other boilers exploded and that these cracks could not have been in the boilers before; otherwise it would have been impossible to keep water in them or maintain the steam pressure. He also believed that differential expansion between the boiler shell and the reinforcing plate was of very little consequence, owing to the fact that this part of the boiler was not subjected to the direct heat of the fire and was considerably removed from the zone of high temperature.

The judge held that whether or not there were negligence on the part of the defendant, the Hartford Steam Boiler Inspection and Insurance Company could be held only for the amount and kind of damages specified in the contract, so that had the jury decided that there had been but a single explosion the damage would have been limited to the $50,000 admitted by the defendant. He did, however, allow the jury to determine what the indirect damages would be, in case of reversal on appeal, and they placed them at $810. The jury found also that there was more than one explosion within the meaning of the contract and awarded the $97,400 agreed upon as direct damages. The case was immediately appealed.



DRUM OF MUNOZ BOILER, SHOWING LINE OF FRACTURE

Methods of Governing Steam Engines

By John Davidson

The two general methods of governing, requirements for speed regulation of different types of engine and a description of several well known throttle governors.

In nearly all cases where a steam engine is used, it is of primary importance to maintain the speed constant, or nearly so. The two principal conditions affecting the speed are the steam pressure and the resistance which the engine has to overcome. Therefore the governor must be able to regulate the quantity or the pressure of the steam, so that the power developed by the engine is just sufficient to overcome all the resistance when running at its normal speed.

The degree of accuracy required depends generally upon the kind of machinery to be driven. For many purposes a governor which is capable merely of preventing the engine from running at an excessive speed is sufficient, whereas for other purposes it is necessary that the governor should maintain the speed under all conditions of load and steam pressure within very closely defined limits, which in special cases are within 1 to 1½ per cent. of the normal speed. Also, the load required of the engine may vary rapidly, and in this case it is necessary that a very sensitive governor be used; or, on the other hand, the variation in load may take place gradually, in which case a slow-moving governor will serve the purpose.

The governor of a steam engine can control only the mean speed of rotation, as the steam is admitted periodically to the cylinder. Between each admission of steam, a variation in the angular velocity of the rotating parts takes place, and this can be minimized only by adding flywheel power. For many purposes it is necessary that this angular variation should be kept within fine limits, in addition to the mean speed of rotation, and under these conditions heavy flywheels are generally used. Besides maintaining a uniform speed of rotation during each revolution, the flywheel greatly assists the governor in cases where a variation in load takes place very rapidly, as is the case where the engines are used for rolling mills and for driving electric generators supplying power for electric railways.

There are two principal methods of governing engines: by throttling the steam and by altering the point of cutoff, that is, varying the degree of expansion. In the first case the quantity of steam admitted to the engine is constant under all loads, the pressure being varied to suit conditions; in the second case the amount of steam admitted to the engine is varied to suit the load, the pressure remaining constant, or practically so. Sometimes the two methods of governing are combined, and when this arrangement is used the engine is usually controlled by the throttle governor entirely at light loads.

Throttle governors are used mostly for small engines, in nearly all cases for high-speed engines of all powers and in cases where the load changes very little and the governor is required principally as a safety device, as for pumping engines, etc. As is generally understood, with throttle-governed engines the most economical load is the maximum load the engine will develop with any fixed cutoff. Therefore, it follows that where a wide variation in load takes place the throttle governor does not give the highest efficiency. It should be noted, however, that where the variation in the load is not very great the difference in economy between variable expansion and throttle governors is practically a negligible quantity.

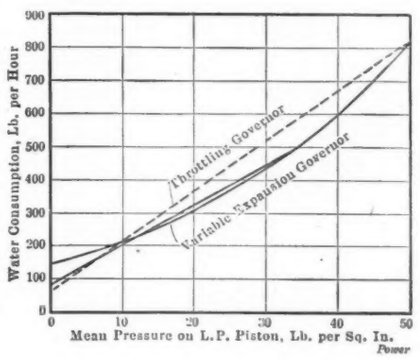


FIG. 1. RELATIVE PERFORMANCE OF THROTTLING AND VARIABLE-EXPANSION GOVERNORS

At light loads nothing is to be gained by variable expansion; consequently by carefully designing an engine it is possible to arrange the cylinders for a degree of expansion which will give good economy over a large range of load. To make this clear, in Fig. 1 is shown the relative steam consumptions of an engine under the same conditions of load when controlled by variable expansion and by throttling.

Suppose that the engine be altered in capacity so that the mean effective pressure referred to the low-pressure piston in pounds per square inch is about 32, then the steam consumption with the throttling governor will be as shown by the full straight line. This shows that, between 32 and 12 pounds mean effective pressure, very little is gained by a variable expansion, and below that load the throttle-governed engine is the more economical.

To maintain maximum economy in throttle-governed engines of the compound and triple-expansion type, when they are required to develop overloads for short periods, bypass arrangements are often fitted, to enable high-pressure steam to be admitted directly to the second cylinder, thus converting the triple-expansion engine for the time being into a compound engine, and a compound into a simple engine. This arrangement is simple, and enables an engine to develop heavy overloads in cases of emergency. However, this practice is not to be recommended, as the distribution of power between the cylinders of the engine when dealing with overloads is very unequal, and unless the moving parts are specially designed to suit these conditions, it is liable to cause unequal wear and overheating. As regards the speed regulation, there is practically no advantage in one method of governing over the other, as the controlling mechanism may be made to act instantaneously in either type.

For special purposes it is often necessary to maintain the speed of the engine constant under all conditions of load. With an ordinary governor, in which the controlling force is due to weights revolving about a given center, it is an impossibility to fulfil this condition, as it is necessary that the speed of the engine vary before there is any change in the position of the governor and consequent variation in the amount or pressure of the steam; that is, the governor itself takes up its position by a change in the speed of the engine. To maintain an engine at a constant speed it is necessary to have a regulating device which automatically speeds up the main governor as soon as a change in the load has taken place.

TYPES OF GOVERNOR

For throttle-governed engines, the governor and the throttle valve may be combined and driven from the engine crankshaft by means of a belt, ropes or chain. This arrangement of governor gear is generally used for small engines, where a device for preventing the engine from running at an excessive speed is practically all that is required. In every case where the governor is driven from intermediate gearing, such as a belt or ropes, an automatic arrangement

should be fitted to shut off steam entirely in case the ropes or belt should break. Many serious accidents have occurred through engines not being fitted with an arrangement of this kind.

Engines running at a high rotative speed usually have the governor attached directly to the crank shaft, thus dispensing with all gearing and making a very compact and safe arrangement. The throttle valve is usually connected directly to the governor, and the latter is fitted with a speeder device, the spring of which acts in such a manner as to close the throttle valve in case the governor itself should break down. The high speed of rotation makes it possible to adopt this arrangement; but, of course, with slow-speed engines it is absolutely necessary to provide intermediate gearing if a powerful high-speed governor is required.

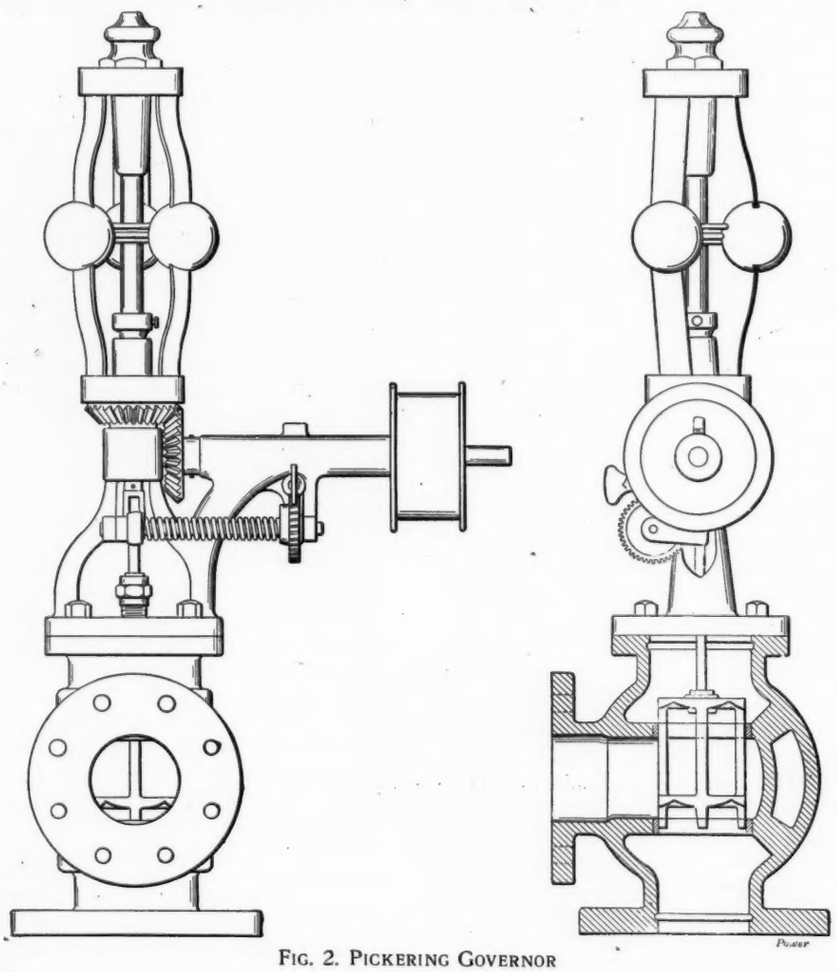


FIG. 2. PICKERING GOVERNOR

Slow-speed engines are usually fitted with steam-distributing valves actuated through trip gears; consequently the governor acts upon the tripping device to modify the point of cutoff. Very little power is required to operate the governor in proportion to the size of engine, as the gears are easily tripped. In the case of engines fitted with rotary cutoff valves, similar to the Ryder gear, a more powerful type of governor gear is necessary, and a governor controlling a relay motor is by far the most satisfactory.

Medium-speed engines are sometimes fitted with governors of the crank-shaft type. In this case the governor has to drive the valve in addition to modifying the position of the gear to change the point of cutoff; hence they are usually of massive construction. This type of governor at one time was extensively used for engines of a high rotative speed but it has now been almost entirely abandoned by English engineers, the throttle type taking its place. A few designs of this type of governor are made, and will be described later.

Owing to the demand for economical high-speed engines, especially for large powers, variable-expansion governing has again been adopted, but in combination with throttle governing. Governors of the flywheel type are not used, and the piston valve is driven in the usual way from an eccentric having a constant travel, the cutoff being varied by slightly rotating the valve which is provided with angular ports, with the liner having angular ports to correspond. Even in this type of governor, as considerable power is required to rotate the valve on its spindle, relay motors are generally adopted in place of putting this additional work on the governor. The governor then simply controls the main throttle valve, and alters the position of a small piston valve in connection with the relay motor.

As a full consideration of the theory and workings of governor gears would be out of place in this article, only the principal designs of governors in general use will now be illustrated and described.

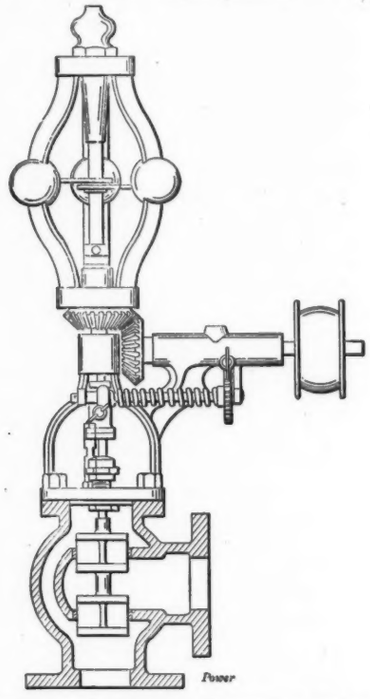


FIG. 3. PICKERING GOVERNOR WITH EQUILIBRIUM VALVE ATTACHED

THROTTLE GOVERNORS

The most common form of combined governor and throttle valve is the Pickering, the general design of which is shown in Fig. 2. In this governor all arms and joints are replaced by flat springs, dispensing with all pin joints and the consequent wear and friction. A neat form of speeder gear is generally fitted, consisting of a torsional spring which tends to close the throttle valve by means of a lever, the pressure being adjusted through the small worm and wheel. The throttle valve being of the double-seated type is balanced, and the edges are vandyked so as to give a gradual opening.

A very effective type of knockoff gear is manufactured by Pollock, McNak & Highgate, of Glasgow, under "Smith's" patent, for this type of governor. The ordinary knockoff gear for governors driven through a belt or ropes consists of a loose arm carrying a jockey pulley, the pulley running on the driving belt or ropes, and dropping in case they should break. This arrangement is not alto-

gether satisfactory for the following reasons: It places the whole stress of the governor on the tension spring, which has to carry the weight of the valve and knockoff gear acts only when the belt breaks, the action of the arm then releasing the spring and causing the valve to close. It does not act when the belt objections are obviated, and if from any cause the governor stops or slows down, it brings the bottom valve of each pair, the two together constituting an equilibrium valve, into action and shuts off the steam from the engine. These valves are shown in Fig. 3. Neither the action of the governor nor its regulation of speed is interfered with in any way. When the engine is at rest these bottom valves are closed, and, in order to start, a small eccentric is used to open them. This is operated by hand, and its action may be understood by reference to Fig. 4. The eccentric is released automatically by the action of the governor after the engine has been started. This arrangement is simple and it is claimed that it is not liable to get out of order, and has the advantage of utilizing the lifting power of the leaf springs.

Sometimes the governor throttle valve and the stop valve of an engine are com-

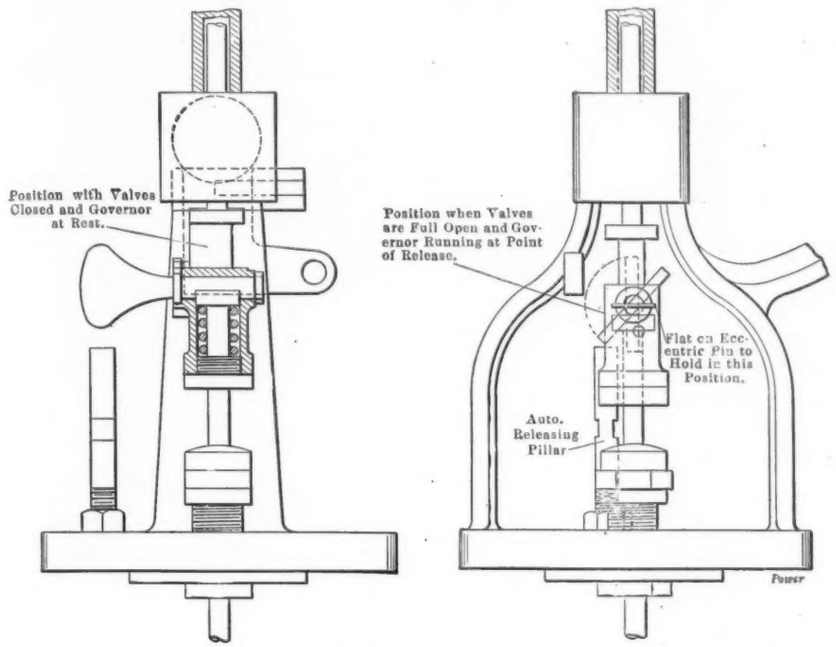

Position with Valves Closed and Governor at Rest.
Position when Valves are Full Open and Governor Running at Point of Release.
Flat on Eccentric Pin to Hold in this Position.
Auto. Releasing Pillar
Power

FIG. 4. ATTACHMENT FOR STARTING ENGINE

spindle; and any downward pull of the leaf springs, when the governor is being expanded by an excess of speed, makes the governor less sensitive and interferes with its exact working. The slides, or the pulley slips on the shaft, nor when a pin or key comes out, but only when the belt gives way.

With Smith's patent automatic knockoff gear fitted to the governor, these

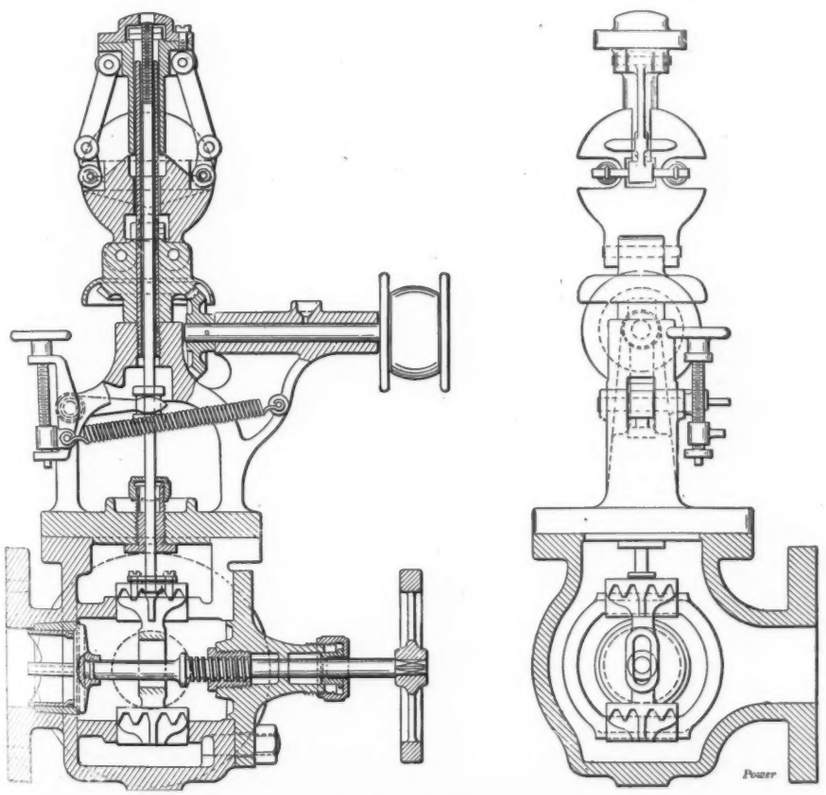


FIG. 5. ACME GOVERNOR

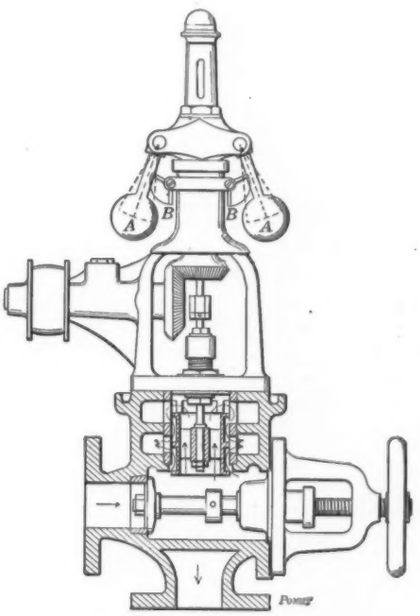


FIG. 6. SOHO GOVERNOR

bined as shown in Fig. 5, which represents a type of governor largely used for all purposes, and known as the "Acme."

Another type of combined governor which is fitted with a safety device is illustrated in Fig. 6; this is known as the Soho safety governor and is manufactured by Messrs. Tangyes, Ltd., of Birmingham. The governor is so designed that if it should stop from any cause, such as breakage of the belt, the throttle valve would automatically close and prevent the engine from racing. The valve is of the equilibrium piston type with double steam ways, thus affording a large area for the passage of the steam with a short travel. To start the engine the balls *A A* must be held up by the supports *B B* as shown in the illustration, and the valve is then full open. When the engine has reached its normal

speed the balls will have lifted and the supports fallen out of the way, leaving the balls free to drop to their lowest position, closing the valve and preventing the engine from running away in case the

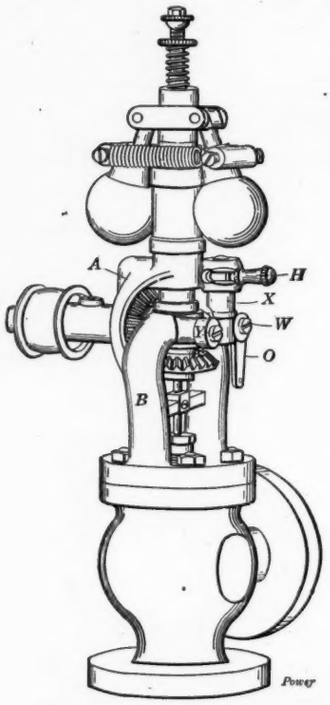


FIG. 7. PRECISION GOVERNOR

governor should cease to run from any cause whatsoever.

In Fig. 7 is shown the Precision spring governor, made by Schaeffer & Budenberg, of London and New York. This governor, although of simple design, is very sensitive, the aim being to reduce friction to a minimum and at the same time to make all parts easily accessible. The governor gear is mounted on a vertical spindle which runs in ball bearings. The tension of the springs increases with the outward swing of the pendulums, the two forces (the tension of the springs and the centrifugal force of the weights) practically balancing each other. The increase in the tension of the springs is practically constant for every equal movement of the weights; consequently the governor is almost astatic. A special type of knockoff gear is fitted which comes into action in case the governor should stop rotating.

The bracket *A*, carrying the governor head and the horizontal spindle with the pulley and bevel wheels, is arranged to slide on and turn round the hollow pillar on the bridge *B*. The bracket *A* is held in the upper position by the collar on the pivot, *X* resting on the rollers *Y* and *W*. In this position the governor acts like any ordinary governor; that is, when the weights are in their "in" position the ports of the valves are full open. If the strap is placed on the pulley, the knockoff motion is put into action by turning the pivot *X* so that the notched portion is opposite the roller *Y;* the bracket *A* is then held in the upper position by the pull of the belt pressing the collar on the pivot *X* against the roller *W*. If the strap breaks, the pivot immediately slides off roller *W*, and bracket *A* with the governor, etc., drops, thus shutting off the valve until the weights fall into their "in" position. By turning the handle *H* on the pivot, the knockoff motion can be adjusted to act for a belt pulley from the opposite direction. The roller *W* is notched and provided with a small lever *O* by which the knockoff motion can be actuated by hand, if necessary, from a distance. If rope or wire connected to the lever *O* is passed under the main belt of the engine, the knockoff motion will be actuated if the belt should slip off the pulley, thus immediately shutting down the engine.

In Figs. 8 and 9 are illustrated a governor, also made by Messrs. Schaeffer &

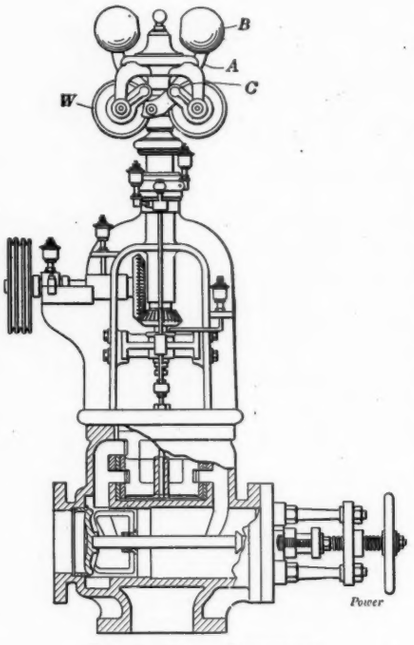


FIG. 8. BUSS GOVERNOR

Budenberg, and known as the "Buss" type. In this governor a compound pendulum is employed, consisting of a bell crank *A*, one end of which carries a ball *B*, and the other a cylindrical weight *W*. There is one pendulum of this description supported on each side of the rotating axis in such a manner that the arm carrying the cylindrical weight *W* extends across the axis. Each pendulum is fitted with a stud *C*, which engages with and imparts movement to the muff. By a suitable choice of weights the system can be made absolutely isochronous within an angle of oscillation of about twenty degrees; beyond this angle the pendulum is in unstable equilibrium. The condition of equilibrium is such that the resultant of the weights and the centrifugal force must pass through the virtual center, which in this case is the axis of support of the pendulum. That is, in Fig. 9 let *F G* represent the resultant of the weights passing through the center of gravity of the pendulum, and *F K* the direction of the resultant centrifugal force, then *F O* represents the direction of the resultant of these forces, and completing the parallelogram *F G H K F*, *F K* represents the magnitude of the centrifugal force. In the middle position this acts upon the weight *B* alone, and therefore the speed may be computed as before. In the other positions, the effect of the centrifugal force must be proportionately distributed over the weights *B* and *W* in order to determine the speed. Between the two extreme positions, the governor shows a variation of only 2 per cent., and it could easily be made more sensitive if desired.

If a governor is made extremely sensitive throughout its lift, it is liable to overrun or hunt. This may be checked —at the same time retaining the highest degree of sensitiveness—by making the governor extremely sensitive about its middle position, but less sensitive upon approaching the highest and lowest positions. This is one of the objects aimed at in the construction of the four-pendulum governor shown in Fig. 10. In this there are four pendulums *A* which are suspended in such a manner that under the influence of their own weight alone they would fly apart until they had nearly reached their extreme outer position, corresponding to the highest position of the governor. They are, however, held in the inner position by the weight of the muff *W* which is applied through the pivots *B* of the pendulums. The latter are supported by short links *C* from the spindle *D*, and the sliding weight, which is made in one piece with

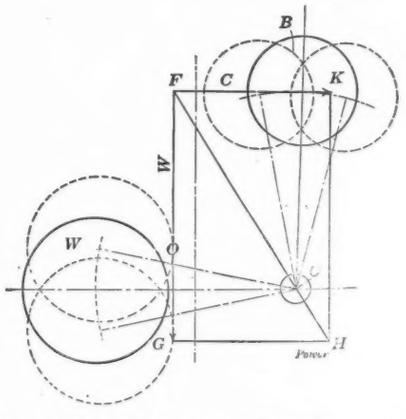


FIG. 9. FORCE DIAGRAM OF BUSS GOVERNOR

the muff, incloses the whole governor. A light spring *E* is inserted to add to the stability and for adjusting the speed. The small view on the left of the pulley represents an arrangement for varying the speed of the governor while in

operation. For this purpose the spindle is elongated and the muff is loaded by means of a spring *S*, which is held down by a nut *F*. By turning the milled wheel *G* the nut is moved on the spindle, and the tension on the spring is varied,

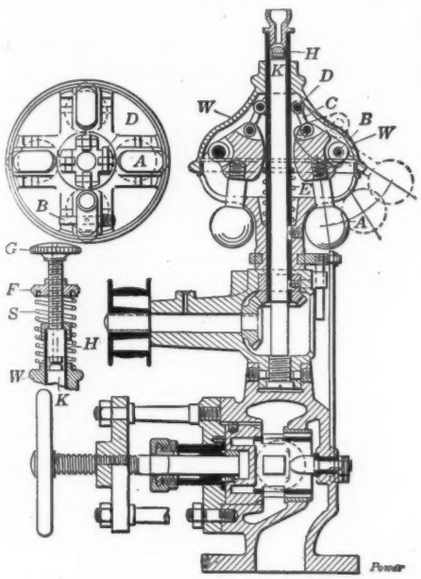


FIG. 10. FOUR-PENDULUM GOVERNOR

which in turn changes the effect of the weight of the muff. By the use of this arrangement the speed of the governor may be varied by about 50 revolutions per minute. This governor is so proportioned that it is almost isochronous about its middle positions, but a velocity difference of 3 per cent. is required to move it from the lowest to the highest position.

A governor constructed in such a manner that the hight of the cone of revolution is constant in all positions of the balls could be in equilibrium only at the one particular speed which corresponds to this hight, and the governor would therefore be absolutely isochronous. This result is obtained if the balls are guided so as to describe a parabola, and supported in a direction normal to the parabola at every point. One possible method of obtaining this consists in hanging the balls from a flexible leaf spring wound upon a base curved to the evolute of a parabola. There are practical difficulties in the way of carrying out this idea, but a feasible approximation to these conditions is found in the Watt governor with crossed arms, if proportioned so that within the range of movement required the arc of a circle described by the balls coincides approximately with an arc of a parabola having its axis in the axis of revolution of the governor.

HIGH-SPEED ENGINE GOVERNORS

As previously stated, the governors of high-speed engines are usually attached directly to the crankshaft and, therefore, revolve at the same speed as the engine. These governors are generally of very simple construction, as illustrated in Fig. 11.

The weights *W W* are pivoted on pins *P P* and by means of extended arms *A A* the motion of the weights is transmitted to the sleeve *B*. One end of the bell crank *C* engages this sleeve and the other end is attached to a throttle-valve spindle. The weights consist of plain steel castings, and adjustment is made by adding weights on either side.

It is now general practice in the case of high-speed, inclosed, forced-lubrication steam engines, to lubricate the main fulcrum pins by oil under pressure. To accomplish this a hole is drilled through

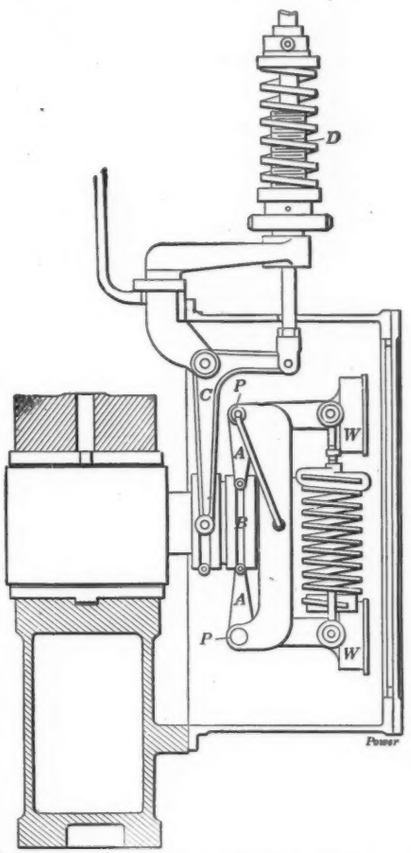


FIG. 11. HIGH-SPEED GOVERNOR

the center of the shaft at the end, connecting with the groove in the nearest end bearing, and from this hole connections are made by means of small pipes to the fulcrum pins.

Referring to Fig. 11 it will be seen that a speeder gear is fitted at *D* just above the casing containing the governor. This consists of a compression spring carried between a bracket fixed to the governor casing, and an adjustable collar carried on a screwed bushing attached to the throttle-valve spindle. By means of a handwheel the bushing can be raised or lowered and the compression on the spring modified, thus altering the speed of the engine. As the throttle valve closes upward it will be seen that should the governor break down or become disconnected from the throttle valve, the spring *D* will immediately close the valve and shut down the engine.

The throttle valves used in connection with this class of engines are generally of the double-beat balanced type as shown in Fig. 12. Steam enters at the top and passes out to the cylinder through the two faces shown. The thickness of the metal in the valve and liner is made as nearly uniform as possible, and being cylindrical in form they retain their shape very well, even when subjected to great variations in pressure and temperature. With a view to reducing friction to a minimum, and at the same time preventing the possibility of an engine attendant interfering with the governing, as might be possible if an adjustable type of gland packing were fitted, a plain bush of considerable length is used. This method of preventing leakage of steam has proved very satisfactory, and a bush will remain tight for several years, providing ordinary lubrication is supplied; and as it is usual to feed the cylinder oil into the pipe next to the throttle valve, the spindle easily obtains ample lubrication.

Throttle valves of the piston type have been largely used, as they can be made perfectly balanced and are easy to actuate; but owing to the fact that it is difficult to adjust them when wear takes place, they have been abandoned by most builders of high-speed engines. With a throttle valve of the double-seated type the wear is automatically taken up by the governor itself, for when the weights

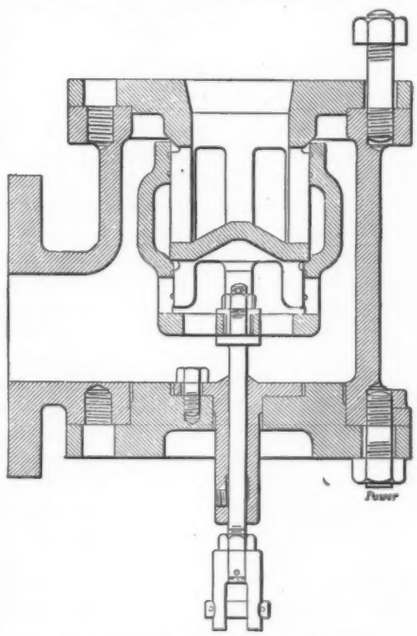


FIG. 12. DOUBLE-BEAT VALVE

are in their out position the throttle valve is forced hard on its seats, and even if it is found necessary to regrind in the valve, the governor will still force it to its seats.

Other types of governor will be taken up in a subsequent article.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

A Unique Gas Power Pumping Plant

By Osborn Monnett

The city of Toledo, though rated as an important lake port, is situated so far back on the Maumee river that it is impracticable to take advantage of the lake as a means of water supply, and it has therefore gone through all the various processes of evolution common to inland cities which have to depend on river supply, such as Cincinnati, Louisville, St. Louis and others in the Middle West.

The original high-duty pumping station took water from the Maumee river at a point about one mile south of the center of the city. The equipment at this point consists of two 5,000,000-gallon Worthington compound duplex horizontal pumping engines; one 7,000,000-gallon Knowles pump of similar type and two vertical compound duplex Worthington pumping engines of 15,000,000 gallons capacity each, making a total pumping capacity of 47,000,000 gallons in 24 hours. Under ordinary conditions the water at this point in the river is moderately turbid except when it is disturbed by high wind or when the clear water has been displaced by highly turbid water from upper portions of the river. The quality of the water on the whole was not satisfactory and a plan was finally worked out of operating the original pumping station in connection with a filtration plant, using the original station, which had ample capacity, for distributing the purified water, and holding the old intake in reserve.

The filtration plant, as finally built, is located at a point 2½ miles up the river from the original station. The water is supplied to the pumps at this station through a 6-foot concrete tunnel by gravity from the filter beds. In connection with the filter plant a low-service gas-power pumping station has been installed for raising the water up to the point where it is purified. This pumping station was originally intended to be located at the water's edge, but upon investigation it was found that the difficulties of obtaining a satisfactory foundation and the danger from high water and ice gorges were such as to make it advisable to adopt another location. It was therefore decided to build the pumping station at a point about 500 feet nearer the filter plant at a considerable distance from the river, as shown in the profile, Fig. 1.

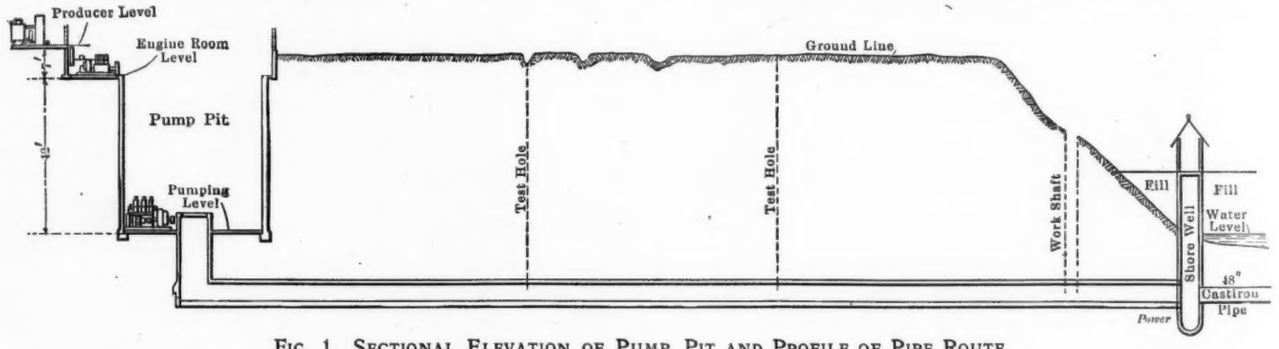


Fig. 1. Sectional Elevation of Pump Pit and Profile of Pipe Route

In order to deliver the water to the pumps in the new location, an intake pier or submerged crib was located approximately 800 feet from the shore toward the channel of the river. From this intake the water flows through a 48-inch cast-iron submerged intake pipe to a concrete shore well 10 feet in diameter; the bottom of this well is 27 feet below mean water level. At a level about 18 feet above mean water level is the pump floor, above which is built a concrete gate house, circular in plan. From the shore well the water flows through a 5-foot brick tunnel, as indicated, 500 feet long, to the suction well in the engine room of the pumping station.

The New Pumping Station

The pumping station proper is a steel and brick structure 65 feet wide and 180 feet long. Fig. 2 gives an idea of the layout as at present installed, with future producer and pumping units indicated in dotted lines. Fig. 3 shows the coaling arrangement. Coal is delivered at the pumping station on a siding elevated some 6 feet above the general ground level. From the cars the coal is either dumped or shoveled into a concrete underground coal bin having a capacity of approximately 250 tons. Underneath this bin is a pit which permits the coal to be drawn from the bin, crushed and delivered to a bucket elevator by which it is deposited in an elevated coal bunker over the stokers, from which point it is spouted by gravity to the charging hoppers. This overhead bin has a capacity of about 70 tons.

Two gas-producer units are in operation but the producer room is planned for a total capacity three times that of the present equipment. Each of the producers now in service is capable of gasifying 300 to 400 pounds of bituminous coal per hour, which will permit each unit to furnish gas for 300 to 350 engine horsepower or to carry a maximum load for two or three hours of 500 horsepower. The generators are of the Wood water-sealed type, 8 feet in internal diameter, with a fire-zone cross-section of 50 square feet. In connection with them are installed two vertical wet scrubbers of the ordinary type and two motor-driven rotary scrubbers which serve also as tar extractors and blowers. The generators are partly shown in Fig. 4 and one of the tar extractors is shown in Fig. 5.

The coal used is Hocking Valley bituminous washed pea, which costs $2.30 per ton delivered at the plant. Up to the present time there has been no attempt to utilize the extracted tar for fuel purposes and considerable thought has been

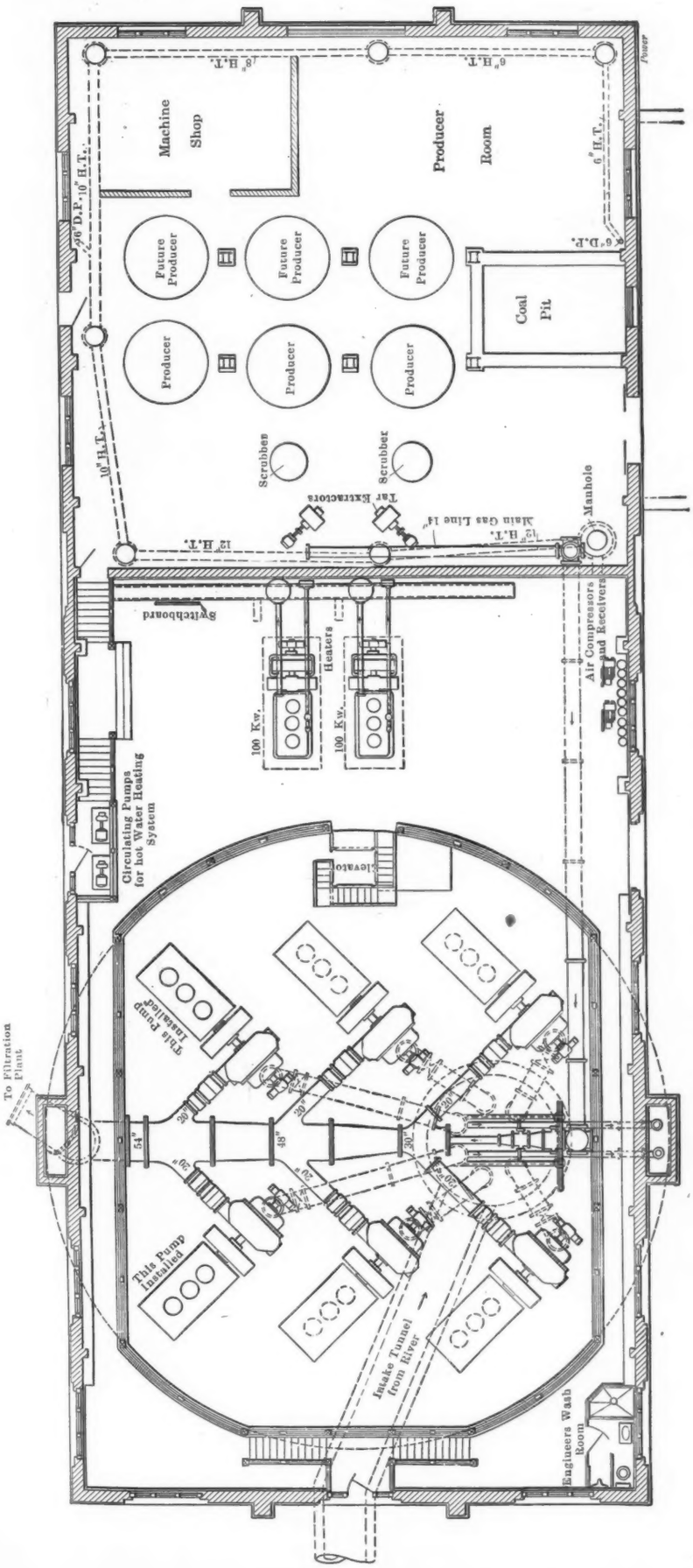


FIG. 2. LAYOUT OF THE GAS-POWER PUMPING PLANT OF THE TOLEDO WATERWORKS

given to the problem of disposing of this byproduct in the most economical way. The method finally adopted and successfully employed at the plant at the present time is to catch the tar discharged from the rotary scrubbers in a water-sealed sump and pump it from there into a storage tank outside the building; from this tank it can be conveniently loaded by gravity into tank cars, for shipment. The pump used for transferring the tar from the sump to the tank is a Marsh pump of special design, driven by steam from a small vertical auxiliary boiler. A ready sale for the tar thus produced has been found, its use being principally for paving material. The purified gas passes into a main header 20 inches in diameter which extends out over the pump

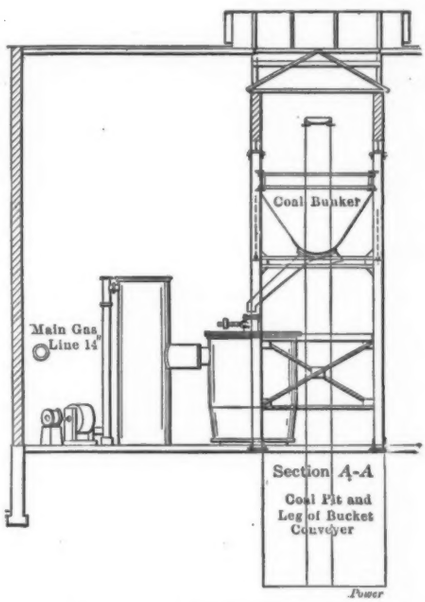


FIG. 3. COAL-HANDLING SCHEME

pit on one side and leads to the engines below. In the construction of this header precautions have been taken to provide for the cleaning of any tar deposit, all angles being provided with cross fittings, enabling the pipe to be cleaned from either direction.

The floor of the machinery room, which occupies the easterly 115 feet of the building, is located 7 feet below the level of the producer-room floor and is in part occupied by a circular pump pit 75 feet in diameter and 42 feet deep below the engine-room floor. On the main floor of the machinery room are located two 100-kilowatt generating units consisting of Rathbun three-cylinder vertical gas engines direct connected to General Electric direct-current dynamos which deliver current at 220 to 230 volts (Fig. 6). These units furnish electric current for lighting and a variety of power purposes throughout the pumping plant and the filtering plant, including the operation of the rotary scrubbers and a number of electrically operated valves, re-

agent mixers, etc., in the other part of the works, and an electric elevator in the pit.

Waste-gas Heating System

One of the interesting details of this plant is the arrangement for heating it with the exhaust gases of the engine. It was originally intended to install in the pumping station two 80-horsepower horizontal return-tubular boilers to furnish heat for the buildings and steam for operating some of the auxiliaries. On investigation, however, it was found that the waste heat from the gas engines would be more than sufficient to accomplish the heating. The method whereby this was accomplished is as follows:

The jacket water from the cylinders of each engine goes to a vertical heater through which the exhaust from the engine is passed. The heaters, one of which is installed for each of the four units, consist of ordinary tubular construction similar to a vertical boiler, with the bottom corresponding to the fire box inclosed to receive the exhaust gases, which pass up through the tubes and out at the top. This muffles the exhaust very effectively and furnishes water at a temperature of 210 degrees Fahrenheit. This water passes through an ordinary system of pipes and radiators heating the different buildings and returns to be again passed through the jackets of the cylinders, heater, etc.

To provide for a proper circulation of the jacket water there have been installed two electrically driven turbine pumps. The water returns to the low-service pumping station from the heating system at a low pressure, which is increased to about 40 pounds by the circulating pumps; this is enough to force it through the jackets, heaters and radiating system and return it to the circulating pumps. The flow is controlled by a hand-operated valve between the circulating pumps and each engine. A thermostat and valve operated by it are located near where the water passes into each jacket and the thermostat is adjusted so that if the temperature of the water entering the jacket should rise above the predetermined temperature, the thermostat valve will open a connection to the mains, where the pressure is about 60 pounds, and admit sufficient water to reduce the temperature of the water entering the jackets to this predetermined temperature. When the heating system is not in use in the summer, water from the mains passes through the jackets and heaters and is wasted.

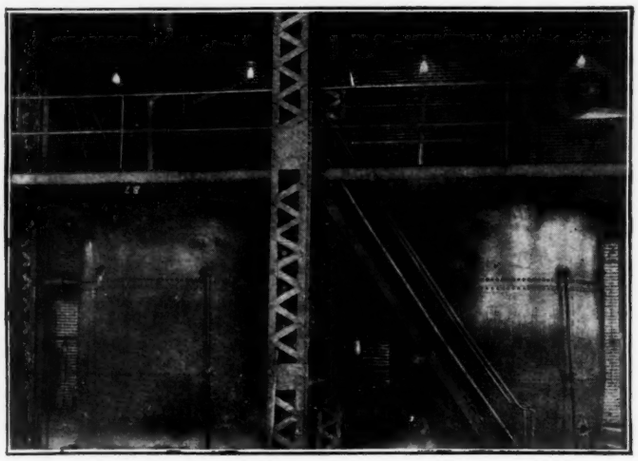


Fig. 4. Upper Part of Gas Generators

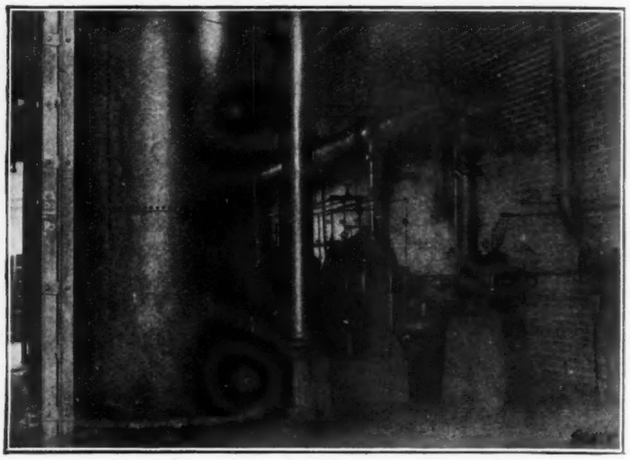


Fig. 5. Motor-driven Tar Extractor

Pumping Equipment

The main pumping engines, shown in Figs. 7 and 9, are located at the bottom of the pump pit and take their suction from the 12-foot well, as indicated in Fig. 2. These units consist of Rathbun three-cylinder vertical engines, with 20x20-inch cylinders, direct connected to two-stage Wood centrifugal pumps, which have a rated capacity of 15,000,000 gallons of water in 24 hours. There is at this point a maximum variation of about 25 feet in the water level

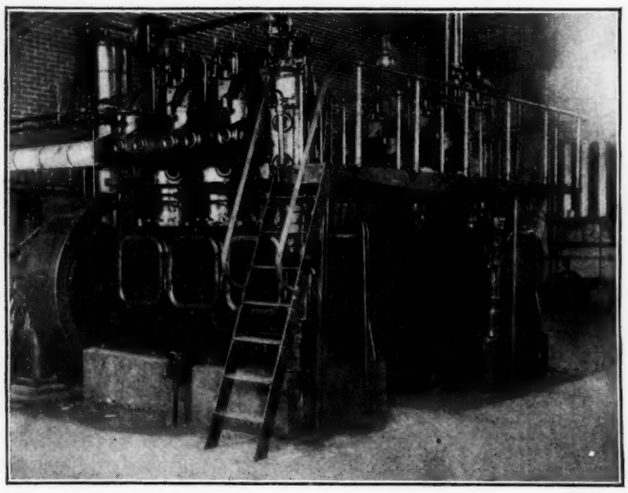


Fig. 6. The Electrical Units

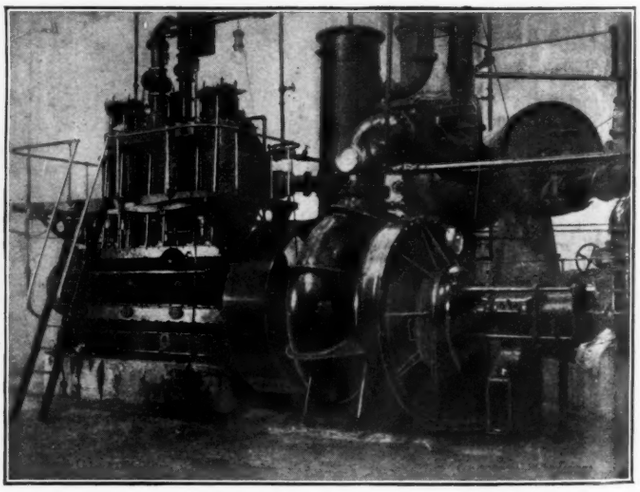


Fig. 7. A Pumping Unit

of the river and the intake tunnel is provided with a throttle valve, operated by hand, for preventing the suction well from overflowing. The water from the two pumping units is discharged through a check and hydraulically operated stop valve into a 54-inch main riser, from which it is taken to the filtration plant.

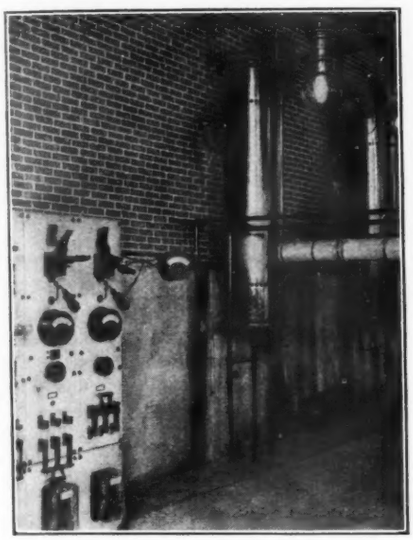


FIG. 8. EXHAUST HEATERS

The engines of these units, as well as those of the electrical units, are of the standard construction regularly used by the builders, but they embody a new valve gear which has not been described in POWER. A lay shaft is located in the crank case and on this shaft are mounted two eccentrics for each cylinder, one to operate the inlet valve and one the exhaust valve. These eccentrics operate, through bored crosshead guides, the push rods which actuate the valve mechanism; the latter is all on top of the cylinders and in plain sight of the operator. Make-and-break ignition is used; the current is supplied from storage batteries which are charged from the dynamos.

In addition to the pumping units there is an auxiliary motor-driven centrifugal pump, having a capacity of 5,000,000 gallons per 24 hours. The motor is arranged to take current from the generators above, enabling them to supply some of the pumping energy in case of necessity.

FUEL ECONOMY OF PLANT

The output of the pumps is measured by means of a venturi meter in the main discharge line and the coal is accurately weighed as it is fed to the producers. Through the courtesy of D. H. Goodwillie, superintendent of filtration, it is possible to present the running results for August and September, 1910, a period of 61 days, under average conditions. The coal consumption was 694,760 pounds and the total output was 560,837 brake horsepower-hours. This gives a record for 61 days of 1.24 pounds of coal per brake horsepower-hour. The coal figures represent the total fuel used for all purposes, including standby losses. The proximate analysis of the coal was as follows: Fixed carbon, 50.25 per cent; volatile combustible matter, 37.32; sulphur, 0.93; moisture, 5.73, and ash, 6.70 per cent. The heat value was 13,200 B.t.u. per pound of coal as used.

In interpreting the results of this run it must be understood that the volume of water being pumped did not provide full load on both of the pumping units; one of them had to be run on a load considerably below its rating, which would naturally lower the efficiency of operation.

The Diesel Engine in Service

BY EDWARD B. POLLISTER

The article by G. H. Kimball in the January 17 issue, on Diesel engine operation, invites a few pertinent remarks from other operators. The article mentioned is instructive—"disadvantages and drawbacks" are not generally found described in catalogs. But do not judge a Diesel engine too hastily. All engine manufacturers have some installations that prove unsatisfactory. Some recent steam-turbine plants have required a couple of years of manufacturers' nursing to secure acceptance.

Take good care of the engine; there is good stuff in it. The shaft is nickel steel and probably bears the welding stamp of some expert in the Krupp works in Germany. But run it 24 hours a day except Sunday; then shut it down for five hours—that is plenty of time for inspection and adjustments. You will finally lose your skepticism, say in six or twelve months' time, with uninterrupted service. And then it is time to start the old steam plant for a few days' run. Take the cylinder heads off for the first time, take the piston out, buy some new rings if needed, and spend some more maintenance money—there will be plenty in the bank by this time. Ten years of average operation of a Diesel engine should leave enough of a fair depreciation fund to replace all the working parts.

A new plant in southern Illinois, consisting of a single three-cylinder unit, operated during the first six months on 24-hour uninterrupted service, with the exception of regular Sunday shutdowns. It showed a total maintenance expense of $4.50 and a switchboard cost of 7½ mills per kilowatt-hour.

The nice thing about the Diesel engine is that it must be kept up. What percentage of 200-horsepower steam engines

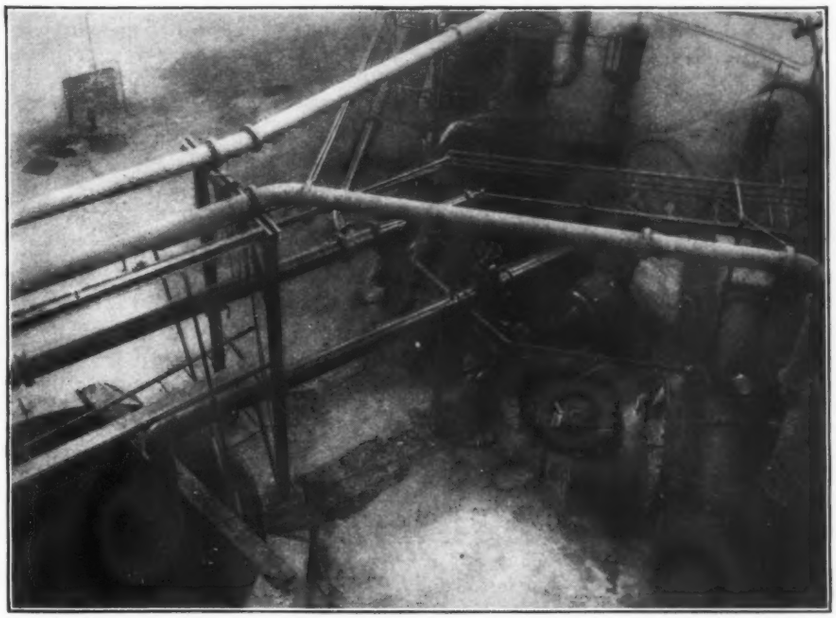


FIG. 9. LOOKING DOWN INTO THE PUMP PIT

are regularly or even frequently indicated? You have got to check up the valves on the internal-combustion engine, and even a small knock is a menace.

Look about a bit. Visit some Diesel plants five years old and upward. Investigate their prosperity—you will find some that are getting on well. I have done so, and without exception have heard praise of the Diesel.

Do not forget that combustion, with a Diesel engine, takes place in the cylinder—a running jump from the boiler grates in economy. In the ordinary lighting plant of a town of 5000, clear a space, say 8x20 feet, in one corner, and install a 160-kilowatt Diesel unit. Close your boiler doors, cut down your force, cut out your firemen, divide your fuel bill by four. Your engineer will have plenty of time to figure out how much cheaper he is manufacturing kilowatt-hours than the city of Boston.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Primer of Electricity

By Cecil P. Poole

Connections of Compound Field Windings

There are two ways to connect up the field windings of a compound-wound dynamo. Fig. 86 shows the method which is generally used; it is called the "short-shunt" connection. Fig. 87 shows the other one, which is called "long-shunt" connection. The reason for these names is that the shunt field winding is connected across the armature terminals only in one case and across the entire armature circuit in the other. In other words, the "short-shunt" connection shunts only the armature but the "long-shunt" connection shunts both the armature and the series field winding.

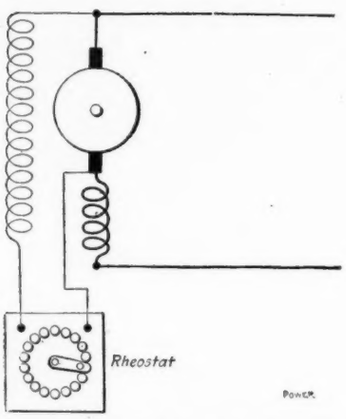


Fig. 86. Short-shunt Connection

There is practically no preference between the two methods. A dynamo will work just as well with one as with the other if the windings are designed for the method of connection that is used.

If a dynamo built with the "short-shunt" connection (Fig. 86) is changed to the "long-shunt" connection (Fig. 87), it will not compound as it was intended to. If it is flat compounded, the voltage will be slightly less at full load than at no load, instead of being the same. If it is overcompounded, the voltage will not rise as far at full load as it was intended to rise.

The reason for this is that the voltage across the brushes is higher than it is across the brushes and series winding, because of the drop in the series winding. Therefore, with the short-shunt connection the full-load voltage at the terminals of the shunt winding is higher than it is with the long-shunt connection.

For example, suppose the no-load voltage at the brushes is 220, the resistance of the series winding is $\frac{1}{10}$ of an ohm, the full-load current 350 amperes and the full-load voltage at the terminals of the dynamo is 240 volts.

At full load the drop in the series field winding will be

$$\tfrac{1}{10} \times 350 = 5$$

volts, and the voltage at the brushes will be

$$240 + 5 = 245$$

volts. Therefore, if the shunt winding is connected to the brushes, it will get 245 volts, but if connected to the outside terminals of the dynamo, it will get only 240.

For the reason just explained, if a dynamo originally built for long-shunt connection should be changed to the short-shunt connection it will give a higher full-load voltage than it was intended to give.

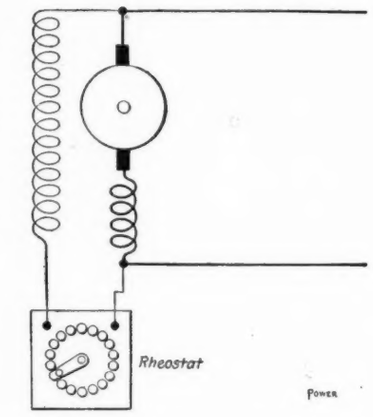


Fig. 87. Long-shunt Connection

Worse still, if the drop in the series winding is unusually high, changing a compound-wound dynamo from long-shunt to short-shunt may cause the shunt field winding to overheat because of the higher full-load voltage. As a general thing, however, the drop in the series winding is so small that neither the difference in full-load voltage nor that in the heating is of much importance.

Since the full-load voltage at the terminals of the shunt field winding is higher with the short-shunt than with the long-shunt connection, the series field winding does not need to supply as large a proportion of the total field excitation when the short-shunt connection is used.

For example, take the machine described in the last lesson. The no-load voltage was 220; full-load terminal voltage, 232; full-load current, 350 amperes; drop in the armature, 5 volts; drop in the series field winding, 3 volts; no-load ampere-turns per field-magnet pole, 7500; full-load ampere-turns, 8700. These figures supply the following comparison:

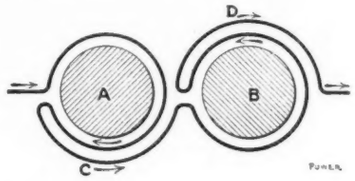


Fig. 88. Effect of Coil Connections

	Short-shunt.	Long-shunt.
No-load volts at shunt-winding terminals	220	220
No-load ampere-turns	7500	7500
Full-load volts at shunt-winding terminals	235	232
Full-load ampere-turns in shunt-winding	8011	7909
Total ampere-turns needed	8700	8700
Ampere-turns to be supplied by series winding	689	791

This comparison is not strictly accurate because the resistance of the series field winding would be slightly less in the first case than in the second, but it illustrates the principle well enough.

Adjusting the Compounding

In the comparison just given, the series field winding was expected to give at full load 689 ampere-turns in one case and 791 in the other. Now, these figures were taken from a machine that delivered 350 amperes at full load, so that in order to get exactly 689 ampere-turns from a series coil it would have to be made with

$$\frac{689}{350} = 1.9686$$

turns, which, of course, is absurd. If two turns could be put in the coil, it would have 700 ampere-turns at full load instead of 689. This would be slightly too much, but in practice it would be considered close enough. However, it is impracticable to get a whole number of

turns in one coil of a field winding when there are two or more coils in a row, all connected together. You can get 1½ turns, 2½ turns, 3½ turns, and so on, but not 1, 2, 3 or 4 turns per coil, unless an inconvenient method of connection is used, and not always even that way.

The reason that each coil will usually

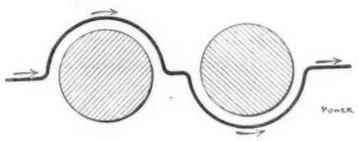


FIG. 89. MAGNETIC EQUIVALENT OF FIG. 88

have half a turn extra will be made clear by looking at Fig. 88 closely. This shows the arrangement of one-turn coils on two magnet cores, *A* and *B*, and their connections. It is evident that the current in the connection *C* neutralizes the current in that half of the *A* coil next to it. Also, that the current in the connection *D* similarly neutralizes the current in the half of the *B* coil beneath it. The result is exactly the same as though the poles were wound each with a half-turn, as in Fig. 89. This neutralizing of half a turn of the winding by the connecting lead almost always occurs when the coil has a whole number of turns in it. Therefore, the effective number of turns is ½ turn less than the whole number.

Now to return to the problem in hand. With 2½ turns per coil 350 amperes will give

$$2\tfrac{1}{2} \times 350 = 875$$

ampere-turns, which is far too much excitation for either case. The remedy is to reduce the current in the series winding and this is done by means of a "shunt" strip connected across the terminals of the series winding, as shown in Fig. 90, where the shunt strip is represented by the zig-zag line at *S*.

With the machine connected up short-shunt fashion, the series winding is to give 689 ampere-turns per pole. With 2½ turns per pole, therefore, the current in the winding must be reduced to

$$\frac{689}{2\frac{1}{2}} = 275.6$$

amperes. To do this, the shunt strip must carry 350 — 275.6 = 74.4 amperes.

Now the relative resistances of two parallel conductors are exactly the same as the relative currents flowing through them, though the larger current flows through the smaller resistance. Since the ratio of currents in this case is

$$\frac{275.6}{74.4} = 3.704$$

the ratio of resistances must be the same, thus:

$$\frac{\textit{Resistance of strip}}{\textit{Resistance of winding}} = 3.704$$

and as the resistance of the winding is 0.0086 of an ohm, the resistance of the strip must be

$$0.0086 \times 3.704 = 0.03185$$

of an ohm.

Let us see how this proves up. With 0.0086 of an ohm resistance in the series winding and 275.6 amperes going through it, the drop at the terminals will be

$$275.6 \times 0.0086 = 2.37$$

volts. And with 0.03185 of an ohm in the shunt strip 2.37 volts at its terminals will cause

$$\frac{2.37}{0.03185} = 74.4$$

amperes to flow through it, which is the required proportion of the total current; 74.4 amperes in the strip and 275.6 in the winding make

$$275.6 + 74.4 = 350$$

amperes, total.

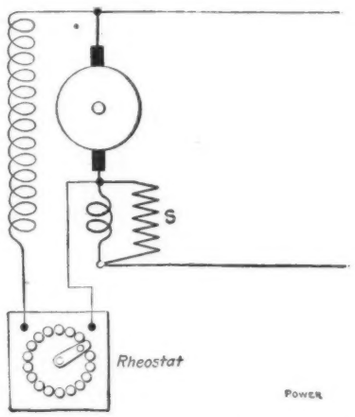


FIG. 90. SHUNT STRIP CONNECTIONS

The case of the long-shunt connection would be figured in the same way, except that the current through the series winding and its shunt strip will be the full load 350 amperes plus the current in the shunt field winding. Thus, to get 791 ampere-turns with 2½ turns in a coil, the current must be

$$\frac{791}{2\frac{1}{2}} = 316.4$$

amperes. Suppose the shunt field winding takes 9 amperes; then the total armature current will be 359 amperes, of which 316.4 must go through the series winding, leaving 42.6 to go through the strip.

The ratio of currents is

$$\frac{316.4}{42.6} = 7.43$$

and the ratio of resistances must be the same. The strip, therefore, must have

$$0.0086 \times 7.43 = 0.0639$$

of an ohm resistance. With 42.6 amperes flowing through this resistance the drop would be

$$42.6 \times 0.0639 = 2.72$$

volts, and this voltage at the terminals of the series winding will force through it

$$\frac{2.72}{0.0086} = 316.4$$

amperes, which is the desired current value.

This last case is not presented with strict accuracy because it was assumed that the drop in the series winding would be 3 volts; the calculation shows that it would be only 2.72, and the shunt ampere-turns would therefore be greater, necessitating fewer ampere-turns in the series coil.

In order to make the results check with each other numerically, a good many more decimal places have been used than are necessary in practice. With the actual machine the shunt strip for short-shunt connection would be figured about this way:

Ampere-turns desired, about 700; amperes necessary, about 280, leaving 70 amperes to go through the strip; current ratio, about 280 ÷ 70 = 4; strip resistance, about 4 × 0.0086 = 0.034 of an ohm. A strip having about 0.05 of an ohm would be selected and the active length of it would be reduced by attaching one lead to a point within the length of the strip instead of at the end. Fig. 91 illustrates one way in which this is done. One end of the shunt strip is bolted to one terminal block of the series field winding, commonly referred to as the "solid terminal," and the strip is clamped to the other terminal of the series winding at a point which depends on how much resistance is desired.

If more current is needed in the series winding, the clamp is loosened and the end of the strip pushed inward so as to

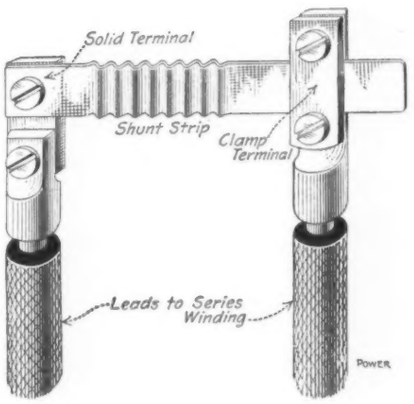


FIG. 91. ARRANGEMENT FOR ADJUSTING SHUNT STRIP

increase the length of strip between the terminal blocks. It is "crimped" to allow this sort of adjustment. Reduced to a few words:

Increasing the active length of the shunt strip increases the effectiveness of the series field winding and, therefore, makes the voltage higher at all loads; this is true for both short-shunt and long-shunt connections.

LETTERS

Static Electricity around Printing Presses

I notice in your January 24 issue an inquiry by A. W. Fish regarding static electricity around printing presses; and I have to offer the following suggestion, which has, in at least two cases, solved the difficulty:

Static electricity is generated usually by friction on the paper and about the press and its parts, and usually during dry, cold weather or cool weather. It is not found to any great extent during damp weather, and this should offer a key to the solution. Most printing establishments are heated either by water or steam, and no arrangement is made for keeping the air moist. My suggestion is to place pans on the steam or hot-water radiators, filled with water, these pans being rather long and deep rather than broad and shallow, so as to hold a considerable amount of water. If the room is a large one, with radiators or coils around the sides, it may be necessary to use artificial means such as small fans for distributing the moisture from the pans around the room. It may require some simple experiment to determine the proper amount of surface to be given to the pans in order to completely eliminate the trouble. The theory of this is that the moisture in the air will allow the dissipation of the frictional or static electricity as fast as it is formed, the moisture acting as a carrier.

I would suggest that it be made the duty of one man to see that these pans are constantly supplied with water, and that the pans are located over coils that are constantly kept in service. If the building is heated by means of hot air from an ordinary furnace, hot-water pans should be installed in the air ducts so that the heated air will pass over them and pick up sufficient moisture to produce the same results.

This expedient has been tried and proved successful in a number of instances. I should be pleased, however, if Mr. Fish would let us know through the columns of POWER what results he obtains if he should try it.

HENRY D. JACKSON.

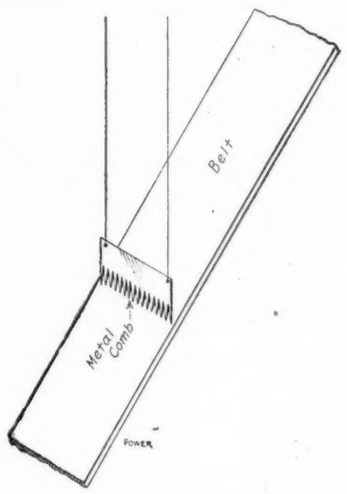
Boston, Mass.

Referring to A. W. Fish's question on how to overcome static electricity around printing presses, I would suggest a method that I found to be of great help to me. Tie one end of a piece of wire to a metal part of the press and attach the other end to any pipe that is grounded, such as a gas or water pipe, preferably the latter. This will enable the electricity to pass off to the ground, just as the ground connection of a lightning arrester takes static discharges off an outdoor line.

EUGENE M. HILBERT.

East Rutherford, N. J.

A simple and efficient method of overcoming static electricity in belts or other moving devices that cannot be easily grounded is to suspend a strip of metal, one edge of which has been cut to form a number of points somewhat like the teeth of a coarse comb, a short distance above and crosswise of the belt; the comb is hung on wires which are grounded to any convenient object, such as a water pipe. I should think this would work also with the paper on a printing press.



TAKING STATIC ELECTRICITY OUT OF A BELT

EARL F. POTTER.

Urbana, Ill.

A homemade "neutralizer" which I have used with success consisted of an automobile induction coil with one secondary terminal grounded and the other terminal connected to a homemade "comb" mounted with its teeth close to the paper passing from the press; the coil was supplied with primary current from a low-voltage "Mazda" transformer connected to the 110-volt alternating-current lighting mains. I short-circuited the vibrator of the induction coil because with alternating current it was not needed and the coil worked better without it. The grounded secondary terminal of the coil was connected to the water pipe and the frame of the press was similarly grounded. High-tension cable of the kind used on automobiles was used to connect the other secondary terminal to the comb.

The comb consisted of a piece of ½-inch brass pipe to which were soldered brass pin points in a single straight line, spacing them about ½ inch apart along the pipe. The comb was mounted on brackets attached to the press frame in such a way that the comb extended at right angles across the sheet of paper, the pin points projecting to within ¼ inch of its surface. Heavy fiber sleeves and washers were used to insulate the comb from its supports. If the discharge from the points is visible, it is liable to set fire to the paper, and the voltage applied to the primary of the coil should be reduced until no sparks can be seen.

S. H. HARVEY.

Hamilton, O.

Static electricity in printing presses may be partially removed by grounding the frame of the press and stretching copper wires along the side of the fly-sticks upon which the paper travels after leaving the cylinder. If the press has automatic jogger boards they may be lined with metal and grounded. This practice proved more successful in my experience than the electric neutralizer, which is expensive and hard to maintain. The draw sheet may be frequently wiped with a rag wet with glycerin, although some pressmen prefer a "dope" made of glycerin two parts and nitric acid one part, which is rubbed over the draw sheet after the mixture has cooled.

It is claimed that this mixture does not swell the packing as much as pure glycerin. In any method so far in use, the electricity is removed only on the press, the sheets again being charged when fed into the folders, where we have no means of removing the electricity.

THOMAS H. WATSON.

Chicago, Ill.

Tinsel cord so placed that each sheet of paper is brushed by it as it passes into the press and another piece of cord where the paper comes out will carry off the static charge. This cord must be connected to the metal frame of the press or to some other good ground. When the static manifestations are particularly troublesome it may be necessary to discharge both sides of the sheet of paper in this manner.

This method of getting rid of the static charge is an old one. It operates upon the same principle as the copper comb so often used in drawing the static charge from moving belts, and if desired a comb may be made for use on the printing press. The easiest way to do this is to take a piece of heavy copper wire sufficiently long to reach across the press and fasten to the frame; strip the insulation from a piece of old lamp cord and cut it into lengths of about four inches or less, as required; solder these to the heavy wire and spread the free ends to form "combs," arranging them so that the sheet of paper passes under them.

A. D. WILLIAMS.

Cleveland, O.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

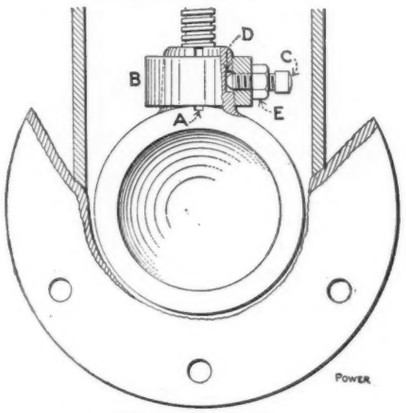
Gate Valves of the Inside Screw Spindle Type

One evening when shutting an 8-inch injection valve connected to a jet, I found that the valve spindle turned without coming to a stop.

This valve was of the straightway inside-screw spindle type and was located so that the spindle stood upright.

I removed the valve cap and found the threads on the spindle and in the plug so worn that the plug would slide over the threads on the spindle.

As the valve had to be in condition to use the next morning in order to regulate the supply of water to the pump, I made a temporary repair about as shown in the accompanying illustration.



SECTION OF GATE VALVE

With a hack saw I cut a slot *A*, inserted pieces of sheet iron in the opening and then sawed down through the hub again until the cut was of the desired width.

In a box of odds and ends a collar *B* with a set screw was found. With a half-round file I tapered the hole in the collar to fit the hub on the plug or gate, and also filed a flat place *D*, on the hub, for the set screw to seat against.

After slipping the spindle into the plug, I tightened the set screw *C* against the hub, which closed it around the spindle, and to prevent the set screw from turning after being adjusted the check nut *E* was used.

When assembled, some pulverized glass and oil was put on the spindle and the plug was screwed back and forth a few times to fit the thread. This was then cleaned off and the spindle coated with graphite and cylinder oil. The valve was then put together and used until a new plug came from the manufacturers.

Experience has taught me that a valve of the outside-screw and yoke type is preferable in such places, because the thread on the spindle can be readily cleaned and oiled.

Another instance where I had trouble with a 3-inch inside-screw straightway valve was where the collar on the spindle roughed up and it was impossible to open or shut the valve. This valve was in a direct steam line, so that there was no chance for lubrication.

I took the valve apart, put the spindle in the lathe and smoothed up the collar and coated it with cylinder oil and graphite before putting it together; but fearing a recurrence of the trouble, I replaced it with one of the outside-screw and yoke type at the first opportunity.

J. W. PARKER.

Clinton, Mass.

Low Water Causes Leaks

I had the day shift in a small steam plant at a mine a little over a year ago and the way that boiler was handled by the night engineer was outrageous. In the first place, the boiler was not large enough to run the mine machinery, being of 45 horsepower and furnishing steam for a 35-horsepower single-drum, direct-motion hoisting engine and an air compressor of the same horsepower.

One night I went up to the engine room and found no water showing in the glass, and the engineer was at the hoist with the throttle wide open, hoisting from the shaft. He said he could keep up steam better with low water in the gage glass. A few days later we had to shut down to expand all of the tubes in the three upper rows, and one week after I counted 27 leaky rivets.

I left soon after as I would rather run chances with men using dynamite with care than with a bad boiler and a man working in ignorance and with carelessness.

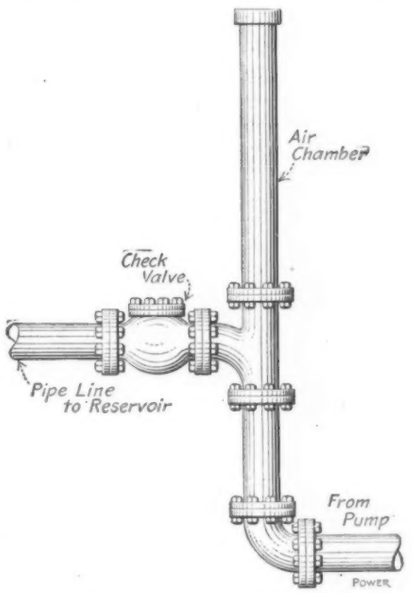
C. F. PINKERT.

Grass Valley, Cal.

Size of Air Chamber

Can some of the readers of POWER give me any information on the comparative effects of long or short air chambers on the discharge line of a pump?

The accompanying sketch shows the discharge of a deep-well power pump, located in a pit. The discharge-pipe line runs to a reservoir on top of a hill 200 feet high and 1100 feet from the pump. The 8-inch by 8-foot air chamber is made



AIR CHAMBER ON DISCHARGE PUMP

of a piece of pipe of the same size as the discharge pipe and is capped on the upper end. The pump is started and stopped a number of times every 24 hours, and often pounds badly. The air chamber is supposed to empty itself when the pump is stopped.

This pound is not caused by loose connections, and some of the local wisemen say the air chamber is too short; others say it is too long, and one thinks an air pump is required to force air into the top of the chamber.

Does good practice fix any definite relation between the diameter of the discharge pipe and diameter of the air chamber; between the diameter and length of the chamber, or between the length of chamber and the pressure in the pipe line? Has a long air chamber any advantage over a short one? What is the effect of a small inlet, as usually seen in cast-iron chambers?

F. A. DEW.

Niles, Cal.

Steam Plant Repairs

Some years ago I was called upon to repair an old whale-back Corliss engine that had a very bad pound, apparently in the crank. The valves had been reset a short time before in an attempt to stop it, but to no purpose. A new cylinder had been put on a year before, so I looked for trouble there. Upon lining up, it was found that the cylinder was ¼ inch too thick from the center line to the side where the bed bolted on, and although the crosshead and crank were in

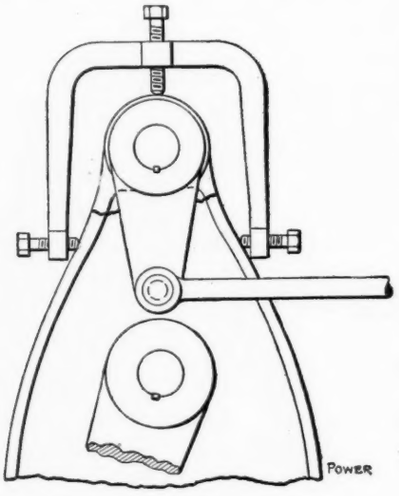


FIG. 1.

line the cylinder was out. This was one of the get out of it cheap cases, so ¼ inch was taken off the front side of the crank-pin box in a lathe and a like amount pinned on the back.

To bring the crosshead in line was more work, but was done by taking the babbitt out of the shoes, and putting the parts all in place, then pouring the new shoes with the crosshead in position. This made the babbitt thicker on the back than on the front, but put the engine perfectly in line.

A boiler feed pump in a central station was repaired as follows. This was a broken rocker-arm stand, and in looking

FIG. 2.

over the stock room a clamp was found with which a very good repair job was made and permitted the pump to be kept in service for some time. The two bottom set screws of the clamp, Fig. 1, were set into the casting solid before the top set screw was tightened. These three set screws held the broken part in place until a new part was secured.

In one case a large duplex pump gave a good deal of trouble with leaky packing. The rods of the water end were of steel and badly pitted on the surface. To save the expense of brass rods, I had the steel rods turned down to a forced fit for 2-inch brass tubing, Fig. 2, which was pushed on over white lead that had been smeared on the steel rods. This made a rod as good as if made of solid brass.

W. E. HOLT.

Medford, Mass.

Economy in the Boiler Room

A problem which every electrical-power station engineer has before him is to deliver a kilowatt-hour of electrical energy to the busbars with the least possible consumption of fuel. This may sound easy, but many times it is a problem difficult to solve.

Before an engineer is in a position to deliver electrical energy to the switchboard at a low cost, it is absolutely necessary that the installation in its entirety shall be in its best possible condition, and every precaution taken against losses which are always occurring.

In order to know just what is being done, a record should be kept as to the output of each unit and also of the coal and water used. With this in hand the engineer is in a position to seek out the losses that are taking place and determine whether they are due to low boiler efficiency, steam losses or wasteful engines, etc.

There are many electric-light and power plants operating at small profits, and there is a great field for improvement in their economical operation. A mistake made by engineers is that of letting what they think is "well enough" alone, instead of making tests and determining whether a certain performance cannot be bettered.

It is a fact that the greatest loss in all steam-generating plants is found in the boiler room; therefore, that is the place to begin an investigation as to the cause for losses.

One matter which should first engage the attention is the analysis of the fuel and also fuel gases, and a general supervision as to the condition of auxiliary apparatus, radiation, feed-water apparatus, method of firing, superheating of steam, if any, and the load factor.

A fireman, to get the best results, must know his fuel. The best results cannot be obtained, however, if frequent changing of the quality of the coal is made, and the engineer should insist that the coal from one mine should be delivered and not accept a cargo of coal from several mines. This applies, of course, where coal is bought in carload lots. It is not a bad idea to ascertain the quality of the coal by repeated tests of these carload lots. When the character of the coal has been determined in a satisfactory manner, the engineer's next duty is to make a complete analysis of the gas from the boiler, keeping a record of the temperature, draft and chemical constituents.

With this information at hand, the chimney losses may be reduced to a minimum; and a greater loss occurs right here than might be imagined. If the maximum efficiency is to be obtained, the quantity of excess air must be as small as possible, and this can only be determined by frequent tests, and generally depends upon the quality of the fuel and on the available draft. Enough oxygen should be combined with the carbon to produce CO_2, which in everyday practice with reasonable attention will be about 12 per cent. with a stack temperature of 600 degrees Fahrenheit or less. In order that this may be known, a recording apparatus should be installed for ascertaining the percentage of CO_2. Without such an apparatus it is impossible to detect air leakage, while with the device the result will be such as to more than repay for the cost. Even with a supposedly tight boiler setting, there will be air leakages which are not detected, and which may become excessive unless constantly attended to.

Any steam boiler should be kept free from scale. The scale question has been discussed so often and so thoroughly that there is little call for any extended remarks upon the subject.

After the engineer has been over his boiler plant and checked all the leakages in the brickwork, has a record of the CO_2 and has secured a good grade of coal at the lowest possible cost, it is then up to the fireman to produce better results and it is a case where the engineer must give his personal attention to the matter and see that the fireman follows out his instructions.

A desirable saving can be made if the load-factor conditions are studied. If it is such as to require banked fires, the load factor should be improved, because the effect is more pronounced in the boiler room than in the engine room, as a banked fire wastes coal. A saving can be made by reducing the number of boilers under steam and increasing the draft by some method to help out at peak loads.

All radiation should be reduced by covering all heat-radiating surfaces with some good nonconductor. In larger plants this will be found to be already accomplished, but in small power stations there is room for considerable improvement.

L. HOLDER.

Ouimet, Can.

Piping a Lubricator to a Reservoir

I would be pleased to see a discussion and illustration of the best method of piping up a lubricator to an oil reservoir published in POWER.

L. J. PIERCE.

Ottens, N. J.

Deplorable Steam Plant Conditions

About one year ago I took charge of the mechanical department of a mill engaged in the manufacture of tin plate. The condition of the machinery of this plant had become such that the continuous operation of it was utterly impossible. Shutdowns in various departments were of hourly occurrence, due, not to the incapacity of the machinery, but to the man in charge.

The accompanying illustration shows two views of a lead gasket that had been placed in an 8-inch steam line directly over the throttle of a 30x60-inch engine. The steam line at this point made a quarter bend, and had been made too short on the end, not meeting the throttle valve by several inches.

To overcome this, the entire line had been sprung down, and the bend stretched out to meet, causing the flanges on the pipe and valve when touching on one side to stand open 5/16 inch on the other. This lead gasket had been made to fill this irregular opening. The inside has not been cut out, but a narrow slit cut through with the idea, perhaps, that the steam would cause it to bend away and leave a free opening, which it did only in part, and the cutting of the steam, as it was wire drawn through it, is shown. Full power could not be obtained from this engine, and the cause was not discovered until leakage required the removal of this gasket. A steel filler faced on each side at a proper angle made this defect right.

On this same engine the valve gear was in very bad shape, and after the valves had been set and the valve rods adjusted to length, the eccentrics were found to be keyed to the shaft (having been done since the engine was erected), and the steam eccentric was so late that the valves did not open until the piston had traveled 4¼ inches. The exhaust valves were late in opening, the piston having traveled 2½ inches before this event occurred.

Alongside of this engine is another of a different make, but of the same dimensions, which worked very badly as regards steam consumption and output. The application of the indicator demonstrated the cause, and the eccentric was found, as in the other case, keyed to the shaft and was 5½ inches of the stroke late. The valve stems and bonnets showed excessive wear, although the superintendent stated that they had been bushed only a short time previous. When taken down for repairs they were found to have been bushed with steel pipe cut to length and forced in.

All steam lines leaked in every joint from the boiler drums to the engines, and in many places there was as much as 2 inches of gasket blown out. One of the flanges were found to be cracked entirely through. Upon inquiry, I ascertained that it had been the custom to sling a chain block from the steam lines to remove the engine-cylinder heads, and on at least two occasions to remove the piston and rod.

It was impossible to make the boilers develop enough steam to run the engines, consequently the management was getting quotations on a new boiler. The boilers were fired with natural gas, using one of the very best designs of burner. They had been formerly fired with coal, but it had been abandoned, as under the conditions it was impossible to keep up steam.

Gas was burned with a pressure of 16 ounces, and at times was raised as high as 45 ounces. The battery consisted of two water-tube boilers rated at 300 horsepower and one boiler rated at 250 horsepower.

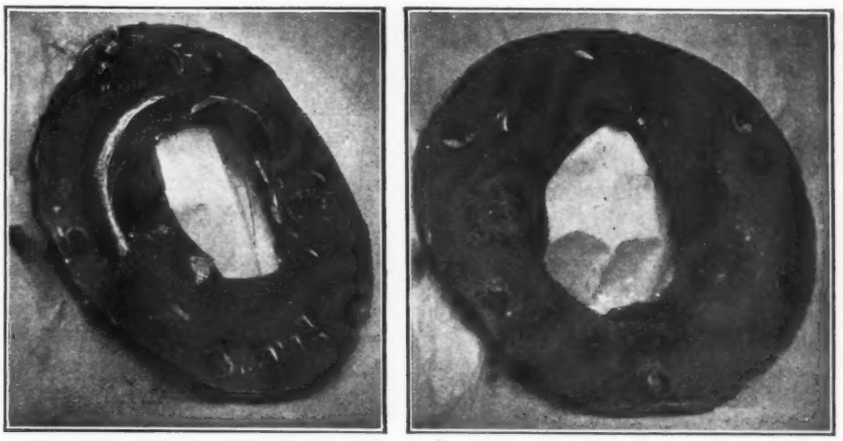
All of the boiler settings were cracked, frames and castings were loose, the dampers were entirely removed and lying on the bottom of the connections to the stacks, bridgewalls had fallen down and were lying in the combustion chambers, checker work for breaking up the gas flames had fallen and were useless, and the feed-water discharge pipes were disconnected and lying in the steam drums.

In the larger boilers a covering of baffle brick, 2 feet wide, had been laid over the first row of tubes in front of the bridgewall. This was filled up by a deposit of dust and ashes solid to the top row of tubes; the baffle plates and brick linings were in a ruinous state.

In the small boiler the same condition existed in regard to bridgewall and checker work. The baffle brick had been removed over the first row of tubes for 16 inches in front of where the bridgewall should have been. The top course was more than half gone. All blowoff valves were leaking a stream as thick as one's finger. Of the three safety valves, one was in working condition, but the others were corroded fast. The steam gages registered from 10 pounds heavy to 20 pounds light. With the exhaust from 1000-horsepower engines blowing into the air, water was fed to the boilers at from 100 to 120 degrees Fahrenheit.

Included in the power equipment was a 50-horsepower gas engine. This engine was running about three-fourths of the time, the balance being taken up in starting and tinkering.

The exhaust-valve stem had worn the adjusting screw down and almost half way through the lever, causing compression of the spent gases during almost one-fourth of the exhaust stroke. The body of the gas cam was cast integral with the bevel gear for operating the governor, the hardened-steel cam being recessed into this. Probably on account of a stripped gear, at some time this cam had been replaced by a new one. The cam was keyed to the shaft, and the new cam, having its keyway planed, was put on as received and was so located that the gas valve was open on the compression stroke, and all the gas that the engine could get was by having the adjustment so that the valve *continually leaked.* A new exhaust valve had been made, which was only ⅛ inch larger than the seat, but this valve was worn down to within 1/16 inch of being through the seat. Making a new valve, boring out the seat and driving in a new seat ring remedied this trouble.



TWO VIEWS OF LEAD GASKET

These are the most prominent examples among the hundreds which could be told of the conditions existing in this plant at that time.

E. E. CASTNER.

Washington, Penn.

Removing Kink from Pipe

In case a length of pipe becomes kinked, heat the pipe to a bright red where the kink shows and then roll the pipe on a perfectly level floor or plate.

E. H. MARZOLF.

Bellaire, O.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Connecting High Pressure Drips to Heating Mains

In the issue of December 27 appears a letter from W. T. Meinzer, describing how "one of our boys" hit on a plan that worked successfully and eliminated the trouble of digging up the lawn and driveways, also the cost of 500 feet of pipe that would have been necessary to return to the boiler room the condensed water from about 15 high-pressure traps in the adjoining buildings.

I think that if he had made the high-pressure traps perform their function, there would not have been very much heating done in the sewers, no more than there would be now to help the low-pressure heating system.

Mr. Meinzer gave us a sketch showing how the pipe connections were made to accomplish the saving of the vapor from the drips. He says "This line was connected to a water seal about 4 feet deep, from the top of the seal in the inlet side. A 2-inch vapor or equalizing pipe was run to the low-pressure heating main to prevent any steam or pressure blowing the seal out into the return to cause water hammer."

I wonder why he did not think of putting in a back-pressure valve. This would undoubtedly have been more effective in preventing back pressure from blowing the seal back into the drip return. Also, it would have been more simple.

As it is now, according to his sketch, both sides of the seal are of the same hight; the slightest amount of back pressure will force the seal back into the return, it being lower than the low-pressure heating main, to which it is connected by the "vapor or equalizing pipe."

This same "vapor or equalizing pipe" will also cause a lot of heat to be wasted through condensation, or, if there be sufficient pressure in the low-pressure main, live steam will blow right through into the returns, not doing any work at all.

Mr. Meinzer fails to state for what purpose they wanted to return the waste from the drips to the boiler room. By returning the water, two purposes might be served. First, the price of the water so returned is saved; second, if the returned water is used for feeding the boiler, and the feed water be heated with live steam, a saving will be made due to the difference between the temperature of the returned water and that taken from the city main, river or well, as the case may be. In any event, I do not think that the saving in this case would justify the expenses incurred by laying a 500-foot return line and tearing up the lawn and driveways.

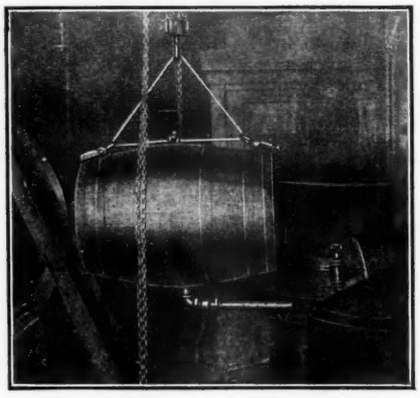
I think that if the high-pressure traps had been put in good working order, there would not have been any loss to speak of on account of letting the drips run into the sewer.

New York City. VICTOR BORM.

Barrel Emptying Device

In a recent issue of POWER there was described a device for emptying liquids from a barrel.

The idea is not a new one, similar schemes have been described before. About four years ago I tried a device like the one described on a barrel of



ARRANGEMENT FOR DRAINING BARREL

heavy crank-case oil with unfavorable results. The discharge pipe was 1 inch and the air pipe was ¼ inch. The barrel was placed in an alleyway beside the oil tank, about 30 feet from the front of one of the boilers.

The air was turned on and I stepped to the tank to see if the oil was flowing. Suddenly, I heard a loud crack and a sort of slopping sound. Turning around, I quickly discovered what had happened. The air had fed into the barrel faster than the heavy, thick oil could flow out and the result was that one of the barrel heads broke. The barrel head hit the front of the boiler. Between the point where it hit and the barrel was distributed the greater part of the oil, slopped all over everything.

After that, I devised the scheme shown in the figure herewith. I had two grab hooks made with a clevis in each one. Then I ran a piece of ½-inch steel cable through them and fastened the ends. I threaded a piece of tapered pipe to fit the bunghole of the barrel. To this I fitted a 1½-inch elbow and on that a valve.

After this piping arrangement was screwed into the barrel, the barrel would be hoisted up with the chain blocks, and a piece of pipe of the right length screwed into the valve. After being hung up, the barrel required no more attention until drained out. While I do not in any way condemn the air-lift device, I think that it should be used with good judgment. The air must be admitted to the barrel very slowly, especially at the start, or the gain in pressure will burst the barrel as in the instance I described.

Glenfield, Penn. L. M. JOHNSON.

Trouble with a Heating Plant

That was interesting reading, the account of his troubles by T. H. De Saussure in the issue of January 10. I know that it must be wearing on the brain and a menace to health to have a problem like his bothering a person.

There is a question I would like to ask him, how did this water that at times filled the boilers up to the top of the water glasses get into the system? If a contractor did a job of piping for me like the one shown, I would have the law on him.

Judged as a heating system that will not work successfully, that shown in his Fig. 1 is a success. Why in the name of "Mike" did he want to have the water pocket in the return from the coils or radiators marked *X*? If he would like to know what change is necessary at the point he writes about to make the system work O. K., I can tell him. All that is necessary is to remove the pipe from the main to the return at the point *A* and take out the pocket in the return, leaving it straight.

The secret of all of his trouble is that the steam pipe has access to the return pipe above the water level in the receiver; the pocket or water seal, as he calls it, only aggravates the trouble.

GERALD GRIFFIN.

Hartford, Conn.

Belt Lacing

I read in the January 10 issue William L. Kiel's article, "Two Methods of Lacing Belts," and, while I admit that the lacings shown have a neat, finished appearance, and are fairly satisfactory when the work the belt has to do is only moderate in proportion to the size of the belt, they are anything but reliable when there is a heavy load on the belt, or where belts have to be run extremely tight, and I have found from my own experience that a much more reliable method is the hinge type of lacing.

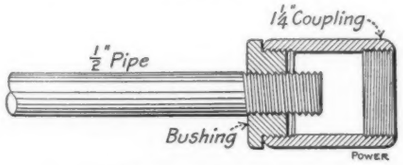
R. R. FORD.

Nemours, W. Va.

Soot Blowers

I have recently read in POWER the articles by W. O. Rogers on soot blowers and suckers and I believe that a little discussion on this subject may be of interest. Mr. Rogers makes a statement that "the simplest form of soot blower is a piece of ¾- or 1-inch pipe attached to a hose, and that while such a device will partly clean a tube, an excessive amount of air is drawn into the tube and that soot is blown about the room."

While the objection to having soot blown about the room is well founded, according to my understanding of the principles of soot blowers the air is not



THE HOMEMADE SOOT BLOWER

objectionable as the end in view is to secure the greatest velocity of steam and air through the tube. Therefore, there can be no excessive air; in fact, some of the blowers are so designed as to draw all the air possible into the tube and thus increase the efficiency of the blower.

A fallacy (so it seems to me) expressed in some of the designs is the apparent effort to make the steam travel along the tube surface with a greater velocity than it does in the center. This is impossible; in fact, the opposite is really the case owing to friction.

Referring to the description of the blower shown in Fig. 25, page 2145 of the issue for December 6, in the last paragraph, it is stated: "The air and steam current is directed by the inverted cone at the front end of the cleaner against the inner wall of the tube for its entire length." I believe that this cleaner would be improved if the cone were removed as the steam and air would then have a free passage to the tube surface, thus insuring the greatest possible velocity. A blower should have a steam nozzle so designed as to convert pressure into velocity and be efficient in drawing air into the tube.

I recall an experience I had with a flue blower when I was running a small plant (my first). The manager asked the engineer of a larger plant to rig up a blower for me. He made one as shown in the sketch. I tried it and not being satisfied with the results I removed the bushing and coupling and got better results; the tubes were 2 inches in diameter.

The statement by Mr. Rogers that the tubes are only partially cleaned is very true, for the blower will only remove the loose matter in the tubes and should be used as an aid to the tube scraper, not as the only means of cleaning them.

I do not agree with his statement in the instalment for December 20 that blowers fixed in the wall are as efficient as the hand blowers, because with the hand blower the steam jet is in the most favorable position to produce a strong blast through the tube, while with the fixed blower the effect is comparatively weak, owing to the distance from the tubes or to the large area of steam opening necessary to take in a number of tubes.

EARL JUBBE.

Cedar Rapids, Ia.

Climbing the Ladder

There have been many salary-raising and encouraging articles in POWER. None has been much superior to the leading editorial in the January 10 issue.

This feeble effort of mine is intended to help some brother engineer or fireman who is discouraged so that he will take a fresh hold of things and keep trying to "climb the ladder," the rungs of which might represent positions in the following order: Laborer, coal passer, fireman, head fireman, oiler, fourth-, third-, second-, first-assistant engineer, chief engineer, consulting engineer, superintendent, general manager and, lastly, president, who is on the top rung.

Not a few men have started from the first and attained the last position. How? The answer is given in the following, which was written by one who knew:

"Hights by great men reached and kept
Were not attained by sudden flight,
But, they, while their companions slept,
Were toiling upward in the night.
Standing on what too long we bore
With shoulders bent and down-cast eyes,
We may discern unseen before,
A path to higher destinies."

What chief engineer who has come up from the ranks cannot look down along the rungs and feel that this experience or that experience has made him a better chief engineer and a better man? Who cannot remember the times he has helped other fellows solve some knotty problem in engineering or lifted other men to better positions by saying to employers, "Mr. A is just the man you want"?

WILLIAM M. GLASS.

Pasadena, Cal.

Selection and Use of Packing

I was very much interested in the communication on the "Selection and Use of Packing" in the January 3 issue of POWER by Charles H. Taylor.

I am what is considered an "old timer." When I was an apprentice, we plaited hemp for packing and with a liberal use of tallow and beeswax it answered very well. However, in these days of high-pressure and superheated steam, this kind of packing would not last long. At present I am using a metallic packing and find it to be quite satisfactory. Of course, there will never be a packing to suit all engineers, for there are as many different kinds of engineers as there are packings.

J. A. EPPLY.

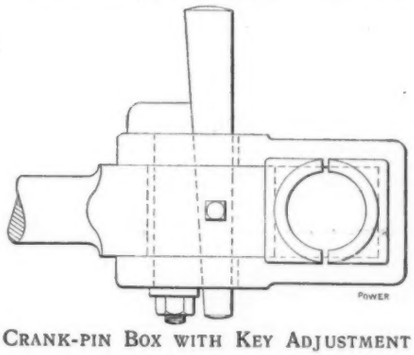
Thomasville, Ga.

Driving Keys

Mr. Stewart, in the January 3 number, in trying to criticize Mr. Taylor on the subject of driving keys has made the matter worse than Mr. Taylor left it.

I believe that Mr. Stewart's method of driving a key is the correct one, but his idea of the effect that the "driving" has on the connecting rod is wrong unless he refers to a type of rod with which I am not familiar.

The accompanying figure shows one



CRANK-PIN BOX WITH KEY ADJUSTMENT

type of rod in which adjustment is made with a key. It is plain that driving the key will draw the strap back on the rod. This may be continued until the box next to the key is worn in two or the key fills the space in the strap or rod.

Mr. Stewart's statement that a liner placed on the key side of the rod, that is, between the brass and the end of the rod, would have the same effect as driving the key, is incorrect for this is the best and simplest means of lengthening the rod.

I think that Mr. Stewart must have in mind a "wedge" instead of a key, but even then he is wrong in his assertion that an engine with a crank-pin key or adjusting wedge on the opposite side of the pin from the connecting rod, and the crosshead key next to the rod, has a tendency to keep the clearance equal, for a wedge has an effect opposite to that of a key.

T. E. HAUGHT.

Means, Ky.

What Causes the Engine to Run?

Since Mr. Teer's puzzle appeared in the November 1 issue, I have been waiting for someone to solve it successfully.

Both Mr. Dunlap and Mr. Libby, in the January 3 issue, seem to have overlooked the fact that the bleeder is connected directly to the exhaust pipe. It does not look reasonable to me that the steam would turn three 90-degree angles and create a greater pressure in the end of the cylinder which is closed than it does in the exhaust unless the velocity which it attains in expanding into the exhaust pipe causes a partial vacuum, thereby creating an unbalanced condition of the piston having a partial vacuum on one side and a slight pressure from the cylinder drain on the other. In this case the vacuum created in the exhaust would have to be greater than the drain pipe which is connected to the end of the cylinder, which is open to the exhaust, would supply.

S. SCARTH.

Newark, N. Y.

The Double Entasis

Referring to the article entitled "A Handsome Chimney," which was illustrated in the January 3 number, it is, perhaps, to be regretted that most industrial plants evidence so little of the "esthetic" or the beautiful in their construction, and, therefore, it may be that no word other than praise should be spoken of this present effort in the right direction. Still, it may be questioned whether or not a chimney top is just the place for a display of elaborate ornamentation. Do not too many frills around the mouth of a smoke vent jar upon one's sense of the eternal fitness of things, much as do the Ionic and Corinthian columns of some old-time engines and machines?

The top of a chimney seems to require some relief from straight-line severity, but the more simply its lines can be given a graceful termination the more correct will be the design. The base of such a structure being removed from the vicinity of the smoke offers a more fitting place for ornamentation than the top. Formerly, the smokestacks of most river steamboats were surmounted by a crown of pointed iron plates shaped like slender leaves of a plant; but latterly these "ornaments" are being relegated to the limbo of things that used to be, and the so called astragals which afford additional surface for the wind to blow against at the top of many steel smokestacks might well be made to follow them.

Whatever is right, looks right; therefore, anything in the nature of a sail on a chimney top must look wrong.

Wonderful people, those Greeks! And it does seem strange that after more than two thousand years we are not able to produce designs so entirely to our credit as their designs were to their credit. In the use of the double entasis the Greeks were right, as usual. In the case of a column supporting a superimposed load it is right and, of course, it looks right. But is not the building of a chimney a problem of another kind? A chimney, exposed to the wind, must act as a cantilever beam uniformly loaded, and such a beam, weaker at the point of support than at other points, is at once recognized as being faulty in design. In the trunk of a tree nature shows the proper form of structure to resist the wind; it spreads out at the base and is firmly secured to the earth upon which it stands.

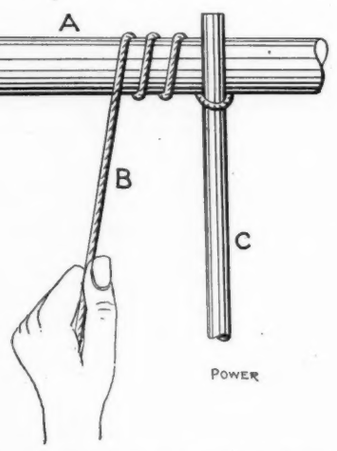
R. E. NELITNAC.

Pittsburg, Penn.

Piston Rod Clamp

In POWER for January 3 I saw a suggestion for keeping a pump rod from turning while tightening or loosening the jamb nuts. I think that the set screw would have a tendency to mar the rod if not bend it.

The accompanying figure illustrates a method which I learned in California 30 years ago. The pipe or rod to be held or



ARRANGEMENT FOR GRIPPING PIPE

turned is represented at *A; B* is a rope and *C* is a lever. The rope has a loop at one end. The end with the loop is lapped around the pipe two or three times, or more, if need be, in the direction that the strain of the lever will be made and the end of the lever is passed through the loop as shown. The rope will grip the pipe without injuring it in any way. The fewer turns of rope there are the easier it will be to slack off to get a fresh bite with the lever. A piece of iron pipe or a hammer handle does for a lever. For polished brass or nickel-plated pipe, use webbing such as suspenders are made of or strong cloth instead of rope and a piece of cloth wrapped around the pipe where the lever touches.

DANIEL ASHWORTH.

Wappingers Falls, N. Y.

Causes of Boiler Explosions

A writer in a recent number of POWER does not believe that a sudden reduction of pressure in a boiler will cause a lifting of the water with dire possibilities. He endeavors to substantiate his opinion by saying that boilers do not explode from a reduction of pressure due to the opening of the safety valve. I take exception to this statement. Anyone who will stop to think, will see that the opening of a safety valve does not reduce the pressure, except the amount of its pop, but prevents it from rising any higher. The safety valve allows the steam to escape only as fast as it is made, while a quickly opened stop valve lets it out faster than it is being made with a drop in pressure in the boiler if there is enough difference between the pressures of the boiler and the main. The greater the variation, the greater the danger.

I believe that the water-lifting action in a boiler under the above conditions has not reached the limit of study. I think it very possible that sheets and joints have been ruptured immediately upon the opening of a large valve, but I consider that more damage has been caused by a surging similar to that so often found in water pipes.

To understand what I mean, consider a possible case. Assume that we cut in a boiler whose pressure is 20 pounds above that of the main. The drop in pressure causes a lifting of the water. This in itself is serious. If the boiler holds, the pressure is soon equalized and the water is thrown down with greater force as it has the assistance of gravity. In this way there are produced a number of hard blows which may rupture sheets, joints or pipe connections or loosen the setting. A broken pipe connection of any considerable size would without doubt be the proverbial last straw, as it would produce a drop in pressure that could not be equalized with safety. A boiler might be "punished" by a water hammer of this nature many times before it let go or it might go the first time, depending on the severity of the "punishment" and the condition of the boiler.

H. K. WILSON.

New Bedford, Mass.

Trouble With Steam Radiator

The reason why E. L. Morris is having trouble with the heating system described in the January 17 number is probably because the feed pipe under the floor should be falling *from* the riser tee to the second radiator. At this point a tee should be used instead of an elbow, and a bleeder or drip connected into it. The drip could be run directly to the cellar and there connected into the boiler return, or it could be run back and connected into the return riser below the

ceiling. I assume that the system is for low-pressure steam.

Another mistake in the work is that only one valve is used at each radiator. In all two-pipe systems two valves should be used at each radiator. An air cock should also be placed on each radiator.

JAMES E. NOBLE.

Toronto, Ont.

If E. L. Morris will put an air-vent valve on the outlet end of the cold radiator, the steam will circulate. The cause of the trouble is that the steam drives the air to the furthest end where it is held by the supply and return pressure.

As a rule, all outlet sections of radiators are tapped for a ⅛-inch air vent.

W. H. PLOWMAN.

Philadelphia, Penn.

I noticed Mr. Morris' letter in the January 17 issue concerning a cold radiator. In his diagram, which is reproduced herewith, it will be noticed that the tee at the top of the riser is put on "bull headed," as steamfitters express it. This tee should be put on in the vertical position, that is, as shown in Fig. 2 herewith. I made such an alteration in a system of which I had charge and overcame thereby a difficulty similar to that described by Mr. Morris.

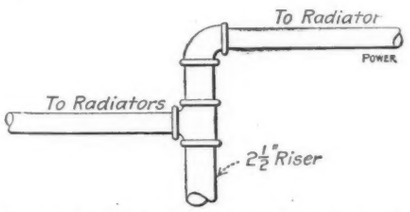


FIG. 2. REARRANGEMENT OF CONNECTIONS AT TOP OF RISER

FRANK MCCOFFIN.

Newport, Ky.

The trouble with E. L. Morris' heating system, as illustrated in the January 17 issue, is that the horizontal leads to the three radiators on the third floor are not large enough.

The central radiator evidently consumes the greater portion of the steam conveyed through the short 1¼-inch horizontal length leading thereto, while the remaining quantity, continuing along through the long lead to the left-hand radiator, condenses on the way and is practically all reduced to water by the time the valve is reached, the returning flow acting to cut down further the already insufficient capacity of the 1¼-inch horizontal pipe.

To make a serviceable job of this part of the system, both the supply and return horizontals should be run 2 inches from the 2½ risers to the middle radiator, and thence 1½ inch to the left-hand radiator, with 1¼-inch vertical connecting branches to each radiator. Likewise, the leads from the risers to the right-hand radiator should be changed to 1½-inch size, with 1¼-inch branches to connect with the radiator.

A. J. DIXON.

Chicago. Ill.

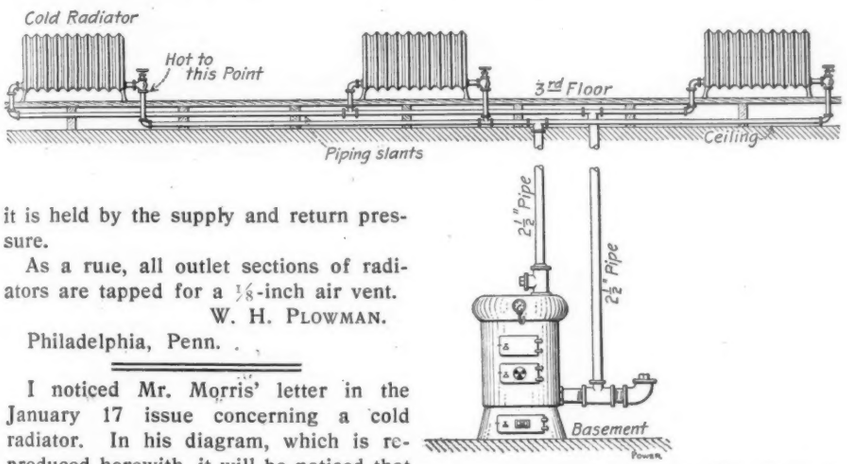


FIG. 1. REPRODUCTION OF MR. MORRIS' DIAGRAM

Cornell Fuel Economizer

I noticed the editorial in the January 17 issue regarding "Impossible Boiler Performances" supposed to have been brought about by means of a Cornell H_2O fuel economizer; and, as I have had some experience with this apparatus, I will recite some of it for the benefit of any engineer who may be curious about this device.

I once took charge of a large building having two 125-horsepower return-tubular boilers, both of which had been fitted with the Cornell apparatus just a little while before I took charge.

The apparatus was supposed to consume the smoke, giving smokeless combustion. All that it did in this line was to whiten the smoke a little by mixing steam with it. I made tests with the apparatus working and also when it was shut off and could see but little difference in the smoke from each fire.

We were instructed to stop or check the flow of steam through the jets. When we did this, condensation would gather and as soon as we opened up the jets again the jets or tuyeres would burst from the sudden rush of water. I tried draining the pipes but it did not help much. Then I removed them altogether from one boiler. We used each boiler alternate weeks. The one boiler used 200 pounds less coal in 24 hours than the one in which the "economizer" still remained, and we had no more smoke than when the apparatus was working, so I threw out the other set also. We then carried the full load, the same as before, on 200 pounds less coal per day. Hence we decided that the apparatus required 200 pounds of coal per day to supply the steam to operate it, besides the cost of renewing the tuyeres or jets, which was considerable.

ALLAN A. BLANCHARD.

Frostproof, Fla.

Fixing Receiver Pressure

I see a great many letters in POWER about receiver pressure. I have found it to be good practice to increase the receiver pressure until it causes the governor to start to drop. Then, to reduce the pressure so that the governor revolves in its highest position.

This rule is convenient for use by those who have not the use of a steam-engine indicator.

J. J. JACKSON.

Waynesburg, Penn.

Water Hammer and Boiler Explosions

I read with interest Mr. Clark's article on "Water Hammer and Boiler Explosions" in the January 10 issue.

I once had serious trouble with water hammer at a mill where there was an installation of four 60-inch by 16-foot return-tubular boilers.

The boilers were connected by a 10-inch header, out of the center of which a 4½-inch pipe led to the engine. This pipe connected into the bottom of the header, dropped about 2 feet and then ran 30 feet to the engine. Of course, this pipe drained the header and came near being the cause of wrecking the plant.

On going to the plant one morning, I found that the night watchman had closed the valve on the 1-inch bleeder that connected into the pipe above the throttle. The pipe was cold and evidently full of water. The steam pressure was well up, ready for starting, but the safety valves were not blowing.

The first move of the bleeder valve caused such a commotion that the fireman and one or two other persons in the plant ran out. Three or four times the violence of the surges and blows threw the safety valves off of their seats. Every time one of those heavy hammer blows came I could see the elbow on the pipe above the throttle move back and forth and shiver.

If a water hammer can cause a safety valve to rise and snort as those did, I believe it might easily cause a boiler explosion, to say nothing of pipe and fitting breakage.

JAMES W. LITTLE.

Fruitland, Wash.

Handling Men

We have been invited to give our views on handling men. There is nothing to it except giving them a square deal, a smile instead of a frown, when possible, maintaining discipline and firing shirks and grouches. I think that this covers the field or subject, though I could fill pages in elaboration of the above and still reserve the privilege of saying more.

J. O. BENEFIEL.

Anderson, Ind.

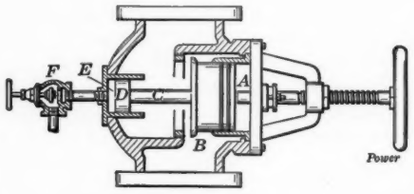
Safety Stops for Steam Engines

Under the above heading some time ago, Mr. Wakeman made some statements that according to his drawings were incorrect. For instance, he had the following to say concerning one of the numerous designs of valve described:

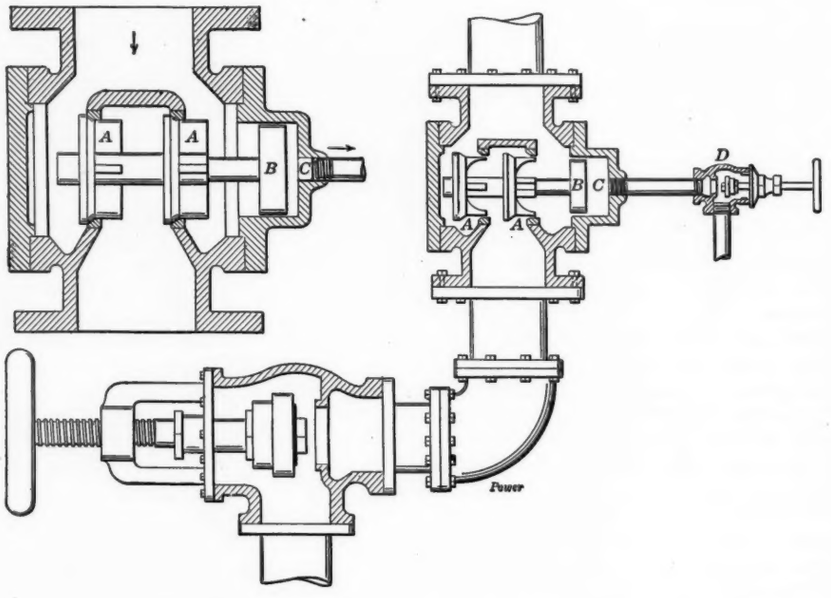
"Pressure acting on *B*, Fig. 3 (which is reproduced herewith), holds the valve open because the full area on the outer face is exposed to pressure, while the rod occupies a portion of the inner face, thus reducing the effective area. Etc."

This would be the case if the stem of the valve extended through the bonnet to the left, but the drawing shows it inclosed and therefore the end of the stem is subjected to the steam pressure. This would give equal pressure on both sides of the piston *B*, and as the main valve is balanced it would remain in any position so long as pressure was maintained in *C*. Should the electrical device act and release the pressure in *C*, the valve would close, but if there is no way of creating a greater pressure in *C* than there is in the steam main, or if some mechanical device has not been provided, the valve cannot be opened.

In the case of another device, shown in Fig. 7 (also reproduced herewith), he reverses the ideas worked out in Fig. 3. He says that piston *D* is in equilibrium, but the figure indicates that there is full pressure in *E* and that the stem terminates in the disk *B*, on the right side of which there is no pressure at all. This arrangement gives a greater effective area at the left of *D*, than at the right. Suppose that the disk *B* is closed, pressure acts on it and *D* alike. But, as the area of *B* is greater than that of *D*, it (*B*) will follow the stem *A* to the right should the handwheel be turned from right to left. When the trip releases the pressure in *E*, the piston *D* is supposed to move to the left and close *B*.



REPRODUCTION OF FIG. 7.



REPRODUCTION OF FIG. 3 OF MR. WAKEMAN'S ARTICLE

But, as *B* is unbalanced and has to close against pressure, the piston *D* would have to be of greater area, while the figure shows that the opposite is the case and, therefore, the valve will not close. In the case of these two valves it would be interesting to hear from Mr. Wakeman as to whether the drawings or his explanation are at fault.

JOSEPH STEWART.

Hamilton, Ohio.

Weighing Small Parts Accurately

Mr. Kirlin, in the issue of January 17, describes a way of accurately weighing small parts without the use of a delicate balance. It certainly is simple and yet a method which one would be unlikely to originate himself in an emergency.

There are one or two places where I believe his method will stand simplification. In regard to the scale ratio, which is 100 to 1, I would like to ask Mr. Kirlin if he generally has his revolver handy to test the scales with. I hope not, for the sake of the poor man who might happen to dispute his weights. Also, does he generally carry a pound of tobacco around with him? Even had he the pound, or any other known weight of it with him, how many times would he find it unsampled, when he wanted to test his scales with it? I think I am safe in saying that all scale weights are marked with both their actual weight and the weight which they will balance on the scales. This, of course, gives the ratio and should be sufficient even if a man is "from Missouri." As an example, a 200-pound balance weight, with the above ratio, would have the numeral 2 under the 200 mark upon it.

With regard to weighing, assume that the ratio is 100 to 1. Suppose the article weighed approximately one pound. By Mr. Kirlin's method this would mean that we would have to hunt around for some thing or things which would weigh about 100 pounds to just balance the article. Quite a little work. And then we would still have the junk to get rid of when finished.

My method would be as follows: I would first step on the scales and find my own weight accurately, say it was 175 pounds. I would then place the article on the tray and repeat, finding my weight then to be, say, 90 pounds. Now, 175 minus 90 equals 85 pounds, which is the weight balancing my article. Then, 85 divided by the scale ratio gives me 85/100 pound as the weight of the article. Of course, if the article had been more than 1¾ pounds, my own weight would not have been enough and I would have had to have a helper or two on the platform with me.

The points I bring out are that it is not necessary to have an *exact* weight to balance the article, the balancing being done by the sliding weight on the arm, and that it is better to have a self-propelled balancing weight in these times of flying machines and automobiles.

JOHN BAILEY.

Milwaukee, Wis.

Cracking noises in steam pipes indicate that they contain water and that an explosion may occur at any moment. Such cases should be carefully inquired into.

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POWER

The Pabst Boiler Explosion Decision

In the suit of the Pabst Brewing Company versus the Hartford Steam Boiler Inspection and Insurance Company, there are two important points at issue.

Does a company which undertakes insurance of apparatus, like boilers, flywheels, elevators, etc., incur liability in excess of that assumed in the controlling policy or contract, for damage from a defective condition which, it is afterward claimed, should have been discovered by the insurance company's inspector?

When several boilers explode at sensibly the same time, is it one explosion or several explosions?

The brewing company claimed that, relying upon the inspections of the insurance company, it had continued to run boilers which were defective until they exploded, and sought to collect from the insurance company, not only the damages resulting directly from such explosions, but such indirect damages as loss of business, increased cost of manufacture, etc.

Against this contention the insurance company urged that they had contracted to pay to the insured damages of specified kinds up to a certain amount, directly resulting from an explosion of one or more of the boilers covered by the policy. They had made no contract to inspect the boilers, were not obliged to inspect them, and if they did inspect them, it was only to protect their own risk, and they were not obliged to report the results of such inspection to the insured, nor liable beyond the terms of the policy for any damage resulting from their failure to make such inspections and report the results.

The court held that the liability of the underwriter was limited by the terms of the contract, or policy, and ruled out any claim based upon the alleged negligence of the company in the matter of inspections.

Any other decision would have thrown consternation into insurance companies of all kinds that maintain inspection service; for if a company making inspection of apparatus or buildings be liable, upon the establishment of negligence, for any damage which may result from the failure of such apparatus or the destruction of the buildings, one might with a $500 policy purchase immunity for any amount, and involve the entire capital of a strong underwriting corporation.

Many patrons of the boiler-insurance companies value the supervision of their boilers by the expert inspectors more than, or as much as, the guaranteed immunity from financial loss. The contention of the insurance company that it need not make such inspections unless it wants to, and is not obliged to report them to the insured, need cause no uneasiness in this respect. It was the logical reply to the contention of the plaintiff. But the only way that a boiler-insurance company can afford to take a risk is by diminishing by inspection the probability of explosion, and the insured are very sure to know the results of such inspection, especially if anything is discovered which is not just right.

The other question—what is "one explosion"—has not been so satisfactorily determined. The Pabst policy covered a battery of six Munoz boilers and was for $150,000 for three years. There had, however, been attached to the policy a "rider" or agreement, supplementary to the main form, providing that "the total liability of the company for loss or damage resulting from any one explosion shall not exceed the sum of $50,000; and in case of more than one explosion, the entire liability of the company shall not exceed the sum insured by this company; viz., $150,000."

At the Pabst plant four Munoz boilers exploded at sensibly the same instant. Was it one explosion or four within the meaning of the policy?

The meaning of the policy is, or ought to be, the meaning which was attributed to it by the covenanting parties when it was drawn up and signed.

Did the man who accepted this policy for the Pabst Brewing Company understand at that time that the failure of each particular boiler constituted a separate explosion, notwithstanding a number of them should fail simultaneously and from a common cause? Do the many business men who hold policies containing this agreement (for it is by no means uncommon) consider that a single accident, involving more than one boiler, constitutes more than one explosion within the meaning of the policy?

If so, they had better have an understanding with the underwriters, for the underwriters' understanding of it is not that way.

The attachment of this rider, or agreement, to the policy very materially lowers

the premium. The underwriter can take the risk for considerably less money when his liability for any one accident is limited to one-third the face of the policy. The probability of three destructive explosions within three years in the same plant is so remote that it is difficult to understand the attitude of a man who pays for such a chance, even at a reduced rate. If he is satisfied that $50,000 will cover any single loss, he would apparently be better off to take a straight policy for $50,000, and renew it, in the remote probability of his collecting it up, than to pay even a reduced premium on a $150,000 policy, upon which he can realize the face value only if he has, within the three-year period of the policy, say three to thirty explosions or tube ruptures in his battery of boilers, each causing direct damage of $5000 to $50,000 or more to persons or property. It was perhaps inability on the part of the jury to understand why a man should pay for such a policy, unless he understood the failure of each individual boiler to be a separate explosion, that led them to find for the plaintiff on this count. Notwithstanding their verdict, we think that the average disinterested engineer would regard the occurrence at the Pabst brewery as "a boiler explosion," that the underwriter has in mind in attaching the rider quoted, that he is limiting his liability for any one occurrence to the sum stipulated, and that the average business man in accepting this modified policy, at a materially reduced rate, recognizes that the stipulated sum fixes the limit of the loss which he can collect at any one time, or for any one occurrence.

Central Station Service in Public Buildings of New York City

The attitude of POWER in the strife between the central station and the isolated plant embraces neither antagonism nor sentiment; it accepts the facts purely upon an engineering basis, and as such recognizes that there is a field in which central-station service possesses advantages over the isolated plant. Nevertheless, when the agents of the former overstep the boundaries of this field and attempt to extend their business through misrepresentation of facts and juggling of figures, we feel it our duty to protest. The recent invasion of the central station upon the public buildings and plants of the city of New York calls for a careful investigation of the facts.

A consulting engineer, employed at a salary of seventy-five hundred dollars per year, to give the city expert advice, made a report—based presumably upon careful tests—relative to the cost of operating the isolated plant at the Harlem hospital. This report showed the plant to be operating uneconomically, and was accompanied by the recommendation that it be shut down and central-station service substituted. Fortunately, the report fell into the hands of those able to analyze power-plant costs and it was discovered that the consulting engineer, in his efforts to present an accurate statement of facts, had included the cost of two hundred and eighty thousand cubic feet of feed water, which, however, if based upon the amount of coal used, would have shown an evaporation of over fifty-five pounds of water per pound of coal, a rather startling figure. On the other hand, his coal consumption was estimated upon the abnormal basis of twelve and a half pounds of coal per kilowatt-hour. Needless to say, this particular recommendation was not heeded; but the fact remains that a number of other city plants have since been shut down upon the advice of this same engineer. That the city officials are beginning to awaken to this condition of affairs is shown by the resolution passed by the Board of Estimate on February 2; this was as follows:

"Resolved: That hereafter no contracts involving electric light or power equipment of any kind in the city of New York shall be advertised for or let by any branch of the city government unless the approval, in writing, of the Department of Water Supply, Gas and Electricity, of the plans and specifications for the work shall have been first obtained, and no alterations to the work as contracted for shall be ordered or approved without the written approval of said department.

"This resolution shall not, however, be deemed to authorize the commissioner of the Department of Water Supply, Gas and Electricity to prohibit or prevent the installation of generating or other electrical apparatus, provided the specifications therefor conform to the established requirements of the said department, nor shall this resolution confer upon the water commissioner any other right or power not specifiedly vested in him by the charter of the city of New York with respect to the use of electricity in any of the public buildings of the city of New York."

The Draft Gage

An instrument whose possibilities seem to have been greatly overlooked is the draft gage. Operating engineers and others who have to do with power-plant design and management will usually encourage the purchase of practically all kinds of instruments except those which will serve to make the fireman's work less a matter of guess work and judgment. And yet, beyond all other operations in the plant, the management of the boiler furnace depends on the personal element.

With a draft gage connected into the breeching at the base of the stack or beyond the damper and another connected with the furnace or first pass, and encouraged to watch the variations in the draft, the fireman should soon learn the importance of keeping the fires clean and the damper suitably adjusted.

Federal Inspection for Locomotive Boilers

The locomotive boiler-inspection bill, mentioned some time ago in these columns, has now passed both houses and will soon become a law.

The effect of the bill will be to put the inspection of locomotive boilers under the charge of the Interstate Commerce Commission. A chief inspector at $4000 a year, with two assistants at $3000 a year each, will have actual charge of the inspection service. Fifty inspectors will do the work of inspecting boilers in the field. Every locomotive boiler will be minutely and carefully examined at least once a year and also at such other times as is deemed advisable. The limit of cost of the service is fixed at $300,000 a year.

Another mysterious boiler explosion was avoided when the fireman of the boiler at the Empire laundry at Poughkeepsie, N. Y., discovered a dynamite bomb in a shovelful of coal which he was about to toss into the furnace. It consisted of a stick of dynamite wrapped in black paper with a percussion cap and fuse. If this was a gentle joke, the perpetrator ought to be dealt with under the impelling force of a conception of the possible results to the thirty-odd employees of the laundry, to say nothing of the neighbors and passers by.

There appears to be a change of policy with respect to the large gas engine. The Tennessee Coal and Iron Company, with a large amount of coke-oven gas available at its Ensley plant, has decided to burn the gas under boilers and use steam turbines rather than to use the gas in large gas engines; and the Cambria Steel Works is installing a 15,000-kilowatt turbine, the steam for which will be made in boilers fired with blast-furnace gas.

A few of us manage to carve our names on the tablet of fame, but some of us never carve them on anything more important than the plank siding of the coal bin.

Every small boy delights to blow a whistle, but that is no excuse for the engineer to play a rag-time tune every time he starts up or shuts down his engine.

"Whenever you see a head, hit it" is a good practice to follow in regard to the little leaks and irregularities in steam-plant operation.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Safe Speed for Flywheel

How can I calculate the safe speed for a flywheel?

B. C. M.

The safe limit of rim speed of a well designed cast-iron wheel is 100 feet per second. The maximum diameter for a given number of revolutions is determined by the formula

$$D = \frac{1910}{R}$$

in which

D = Diameter in feet;

R = Revolutions per minute.

Conversely,

$$R = \frac{1910}{D}$$

High- and Low-pressure Pumps

What is the difference between a high-pressure and a low-pressure pump?

H. L. P.

A high-pressure pump is one that is used to pump against a pressure as high or higher than that of the boiler which furnishes the steam. A low-pressure or light-service pump, as it is sometimes called, is one designed for pumping against pressures below that in the boiler and the water cylinder is of a greater diameter than the steam cylinder.

Thickness of Cylinder Walls

Please give me a formula by which I can calculate the proper thickness of a steam-engine cylinder.

E. H. B.

For a good quality of cast iron

$$Thickness = 0.0004 \times Diameter \times Pressure + 0.3 \text{ inch.}$$

The 0.3 inch is added for reboring.

Hight of Suction Lift

In a well the water level is 25 feet below the surface. Will a 4½x2¾x4-inch duplex pump operate satisfactorily at this lift and discharge water 10 feet above the pump?

A. L. B.

With the pump in good working order there is no reason why the pump will not work well. The piston and the valves must be tight, as slight leaks past either will interfere with the operation. A foot valve should be placed at the lower end of the suction pipe to facilitate priming when it becomes necessary.

Compounding Separate Engines

Can two simple engines, each having the same length of stroke, running at the same speed, and both connected to the same line of shafting be run as a cross-compound engine?

C. S. E.

Yes. The cylinder diameters will, however, have a great influence on the practicability of the scheme.

Cause of Increased Receiver Pressure

In a cross-compound engine with a separate governor for each cylinder with a varying load the receiver pressure rises with a light load and falls with a heavy one. What is the cause of this and what is the remedy?

I. R. P.

The range of cutoff on the low-pressure cylinder is too long. The cutoff is too short on light loads and may be too long for heavy ones. The cutoff on the low-pressure cylinder should vary the same as that on the high. Then the receiver pressure will be constant and the load evenly distributed.

Evaporation from and at 212 Degrees

Please explain what is meant by the expression "from and at 212 degrees."

R. A. S.

When water is fed to the boiler at a temperature of 212 degrees and evaporated into steam at atmospheric pressure, the steam has a temperature of 212 degrees and the evaporation is said to have taken place from and at 212 degrees. As this requires a definite amount of heat, it has been adopted as a standard to which all boiler performances are referred when tests or comparisons are made.

Cutoff on Low-Pressure Cylinder

If the point of cutoff in the low-pressure cylinder makes no difference in the number of expansions, of what use is a cutoff on this cylinder?

L. C. O.

It is used for controlling the receiver pressure and distributing the work between the cylinders.

Effects of Bag on Boiler Safety

On the front sheet of a boiler over the fire a small bag about 2 inches deep has formed. Is it dangerous?

B. B. S.

It is not necessarily dangerous. The sheet at the thinnest part of the bag is probably stronger than the seam, and if kept free from scale or deposits of mud is not unsafe. However, the matter should be referred to an experienced boiler inspector.

Draft Regulation

What is considered the best practice to regulate the amount of air supplied to the furnace: by the damper or by opening and closing the draft doors?

R. E. H.

The draft should be regulated by the damper.

Air Receiver Explosion

I am using an old return-tubular boiler in a cellar as a receiver for compressed air at 100 pounds pressure. If it should explode, would the results be disastrous?

E. A. R.

Probably not. It would be a case of simple rupture, which, if it occurred at the side, would move the receiver a few feet from its position.

Water Hammer in Open Pipe

What is water hammer, and is it possible to get a water hammer in the exhaust pipe of a steam engine?

J. I. W.

Water hammer is the violent projection of a body of water against some part of the interior surface of the containing vessel or pipe. It is possible to get a water hammer in an open-ended exhaust pipe if there are water pockets.

Effect of Clearance

How is the ratio of expansion found when the clearance is known?

E. O. C.

The ratio of expansion is found by dividing the final volume by the initial, or volume at cutoff. When the clearance is considered, the percentage of piston displacement represented by the clearance is added to both the initial and final volumes. If the piston displacement be represented by 1, the final volume will be 1 + per cent. of clearance, and the ratio of expansion will be

$$\frac{1 + clearance}{Cutoff + clearance} = Ratio\ of\ expansion$$

Sizes of Turbine Steam and Exhaust Pipes

The accompanying curves were prepared by W. J. A. London, chief engineer, of the Terry Steam Turbine Company, Hartford, Conn., to save the necessity of working out the size of steam and exhaust piping for each individual calculation.

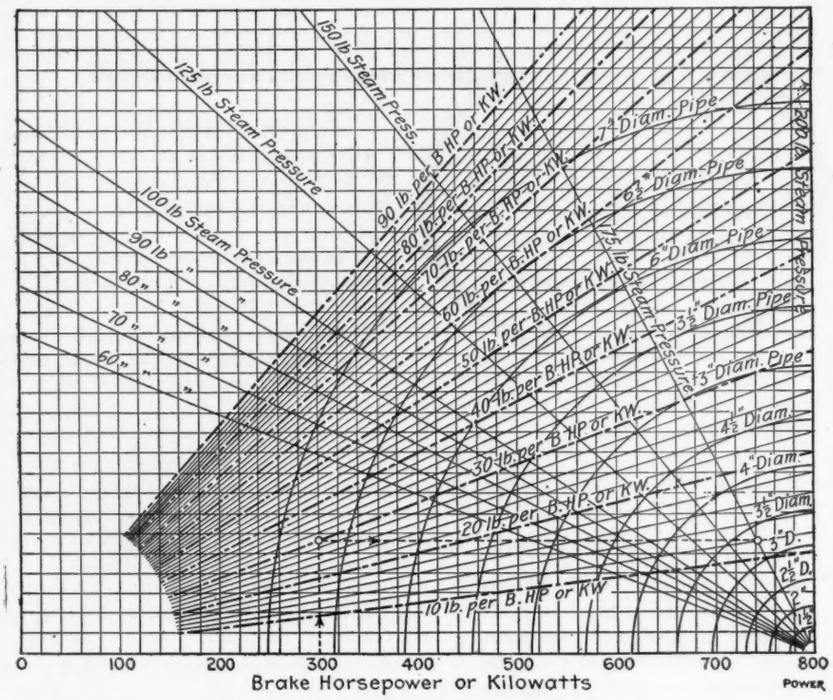

150 lb Steam Press.
125 lb Steam Pressure
100 lb Steam Pressure
90 lb " "
80 " " "
70 " " "
60 " " "
90 lb. per B.HP or KW.
80 lb. per B.HP or KW.
70 lb. per B.HP or KW.
60 lb. per B.HP or KW.
50 lb. per B.HP or KW.
40 lb. per B.HP or KW.
30 lb. per B.HP or KW.
20 lb. per B.HP or KW.
10 lb. per B.HP or KW
7" Diam. Pipe
6½" Diam. Pipe
6" Diam. Pipe
5" Diam. Pipe
4½" Diam.
4" Diam.
3½" Diam.
3" D.
2½" D.
2"
1½"
75 lb. Steam Pressure
50 lb. Steam Pressure
0 100 200 300 400 500 600 700 800
Brake Horsepower or Kilowatts
POWER

FIG. 1. SIZE OF STEAM PIPE TO TURBINE

Having given the power, water rate and steam pressure, the size of the steam pipe is obtained as shown in the example relating to Fig. 1. Thus: Assume 300 horsepower at 30 pounds water rate, with 175 pounds initial pressure. Follow up the 300 line to the 30 pounds water rate, and from the intersection run to the right to the initial-pressure line, and in the example this is between 3- and 3½-inch pipe, and will therefore take the larger size.

For determining the exhaust outlet when given the power, water rate and back pressure or vacuum, use Fig. 2 and in exactly the same way.

The steam-pipe sizes are based on the standard steam velocity of 100 feet per second or 6000 feet per minute, using dry saturated steam. The exhaust curves are based on a velocity of steam of 400 feet per second or 24,000 feet per minute for all vacuum curves; 100 feet per second, 6000 feet per minute, for the atmospheric-exhaust curve is allowed.

In all these curves steam has been taken as expanding from 150 pounds gage, and from Peabody's steam tables, which have been used throughout the calculation; this gives an entropy of 1.56. In cases where the initial pressure is different from that stated, a small correction should theoretically be made for the difference in moisture, but the percentage difference in ordinary work in expanding from 200 pounds to 1 pound absolute, and from 100 pounds to 1 pound absolute, is so small that the curves will be found sufficiently close for all practical purposes.

All pipe diameters given are based on net internal areas. As the net areas of extra-heavy pipe and double extra-heavy pipe are very often considerably less than the normal diameter of pipe, corresponding allowances should be made.

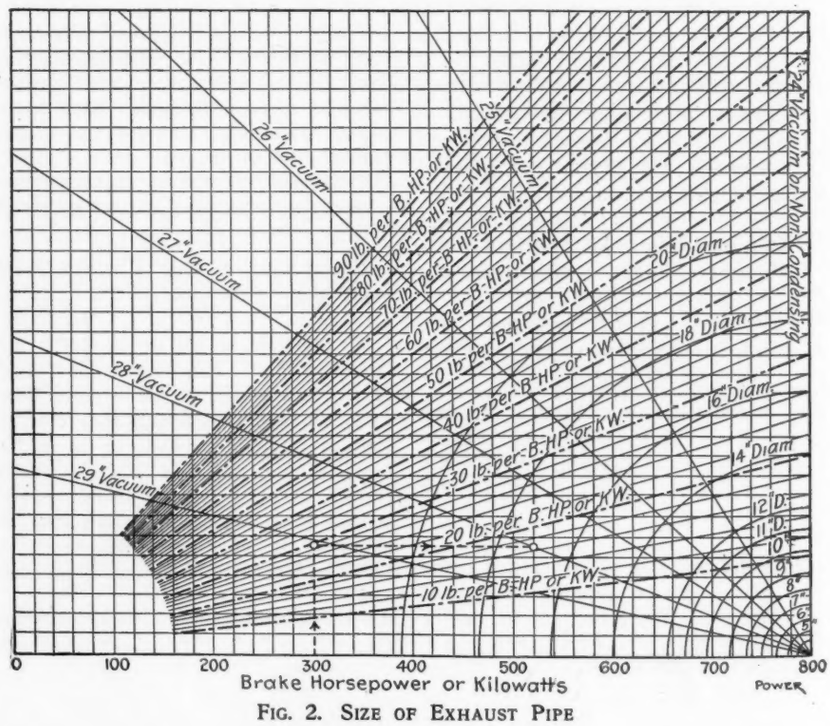


FIG. 2. SIZE OF EXHAUST PIPE

General Electric Centrifugal Air Compressors

A score of men connected with blast-furnace operation were the guests of the General Electric Company at the River Works, Lynn, Mass., on February 4, to inspect the design and construction of the three new turbine-driven, constant-volume centrifugal air compressors which are to be delivered to the Iroquois Iron Company at South Chicago, Ill.

One of these compressors is completed and erected on the testing floor; an actual demonstration of its operation was made.

These machines will constitute the third installation in the United States of this type of compressor. The first machine to be installed was that at the Oxford Furnace of the Empire Steel and Iron Company, Oxford Furnace, N. J.

The Cambridge Scientific Instrument Company showed several novel instruments at the recent exhibition held by the Physical Society of London. The first of these was the bi-meter carbon-dioxide recorder, which contains no glass nor liquid, the CO_2 being absorbed by lime and being recorded by the aid of a differential gearing between two cylinders, through which the flue gas is drawn. The second, the recalescence curve tracer of H. Brearley, of the Firth Laboratory, of Sheffield, gives recalescence curves on a very open scale of rectangular coordinates, connecting time and temperature with the aid of a thermo-couple and a galvanometer. One clock drives the whole mechanism. The observer has to turn a handwheel in such a way as to keep the pointer coincident with the light spot of the galvanometer mirror.—*Ex.*

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Tools for Placing Baffle Brick

This set of two tools has been designed for the purpose of removing and replacing baffle walls of Babcock & Wilcox boilers.

Ordinarily when removing baffle bricks it is necessary to break them before they can be taken from between the tubes. When replacing new baffle walls, using old methods, it is necessary to chip the edges on two sides of each brick before it can be put in place between the tubes. With the new method the brick are put in place whole and set up snug against the tubes.

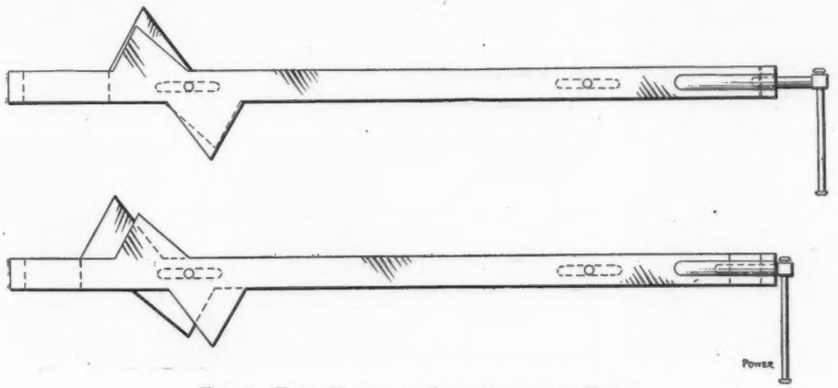


FIG. 1. TOOL USED FOR SPRINGING THE TUBES

In Fig. 1 is shown the tool used for springing the tubes. It is made with an adjustable spreader head. The movable part is operated by a threaded stem that screws into a nut on the inside of the handle, and is operated by the rod on the end. The upper view shows the tool in a contracted position; the lower view as it appears when the tubes are sprung.

By referring to Fig. 3 it will be seen that four tubes are sprung as the head is expanded; that is, tubes *A* and *B*, which bear against the stationary portion of the head are sprung away from the tubes *C* and *D* which bear against the movable part of the head. With the tubes sprung in this manner, it is a simple operation to remove an old baffle wall and replace it with new baffle bricks.

Fig. 2 illustrates the tool used for placing the baffle brick in position. The upper view shows the brick as it is placed in the tool; the lower view shows the brick gripped by the jaws of the tool. The gripping member is adjusted by a threaded rod which passes through a nut on the inside of the handle. The nurled end of the handle is turned, which tightens or loosens the jaws of the tool on the brick. The stationary member is so made that it fits the end of the baffle brick.

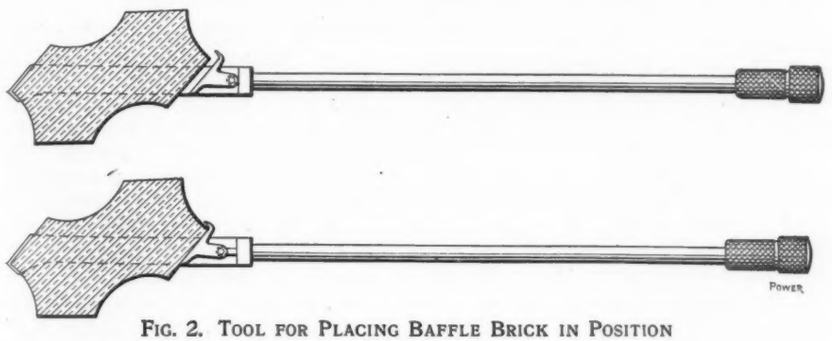


FIG. 2. TOOL FOR PLACING BAFFLE BRICK IN POSITION

With the brick gripped in the jaws, the tool is inserted between the boiler tubes, and when in place the movable jaw is drawn back and the tool removed.

By using these instruments the baffle brick can be replaced whole and thus their efficiency is not impaired.

These tools are made by J. Keers, 224 Eighty-first street, Brooklyn, N. Y.

Albee Crude Oil Burner

This device has been designed for use in the furnace of steam boilers, forges or wherever crude oil can be utilized as a fuel.

It consists of a main body *A* which has an air and oil inlet and a discharge outlet. Oil is discharged into the burner through the plug *B*, in which is screwed a nozzle *C*. This plug has a wire screen *D* that is held in place by the cap *E*.

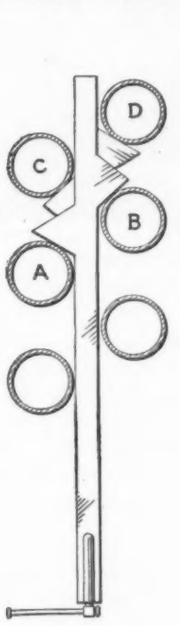


FIG. 3.

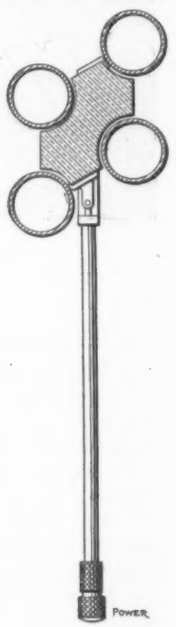


FIG. 4.

To the discharge end of the burner is screwed a cast-iron pipe having an outlet formed as shown in the illustration. This extension piece passes through the brick wall of the furnace front, and is the only part of the burner that is exposed to the furnace heat. When it does become burned, it is easily renewed at a small cost.

When in operation the furnace works as follows: Oil is forced through a sup-

ply pipe to the inlet of the burner and out through the small discharge hole in the nozzle *C*. Air, under a three-pound pressure, is admitted to the body of the burner through the top opening and

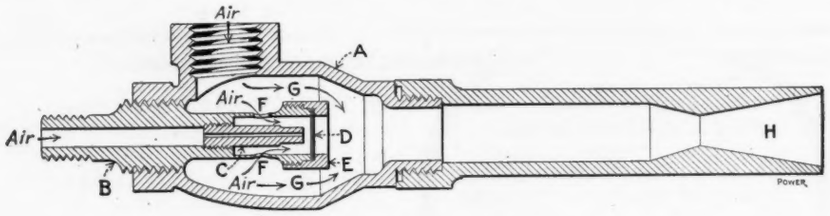


FIG. 1. SECTIONAL VIEW OF THE ALBEE CRUDE-OIL BURNER

travels along two paths before it is expelled at the discharge end. That is, a portion of the air supply passes to the interior of the plug *B* through a series of holes as shown at *F F*. This air mingles with the incoming oil from the nozzle *C* and passes through the wire screen *D* in a partially atomized state, the current of air and oil passing diagonally from one side of the burner to the other from all points of the discharge cap *E*.

As this current of air, indicated by the arrows *G G*, strikes the oil and air being discharged through the cap *E*, the mixture is blown through the expanding tube and is discharged at the end *H* in a vapor, and is then ignited in the furnace of the boiler.

An oil connection is made to the supply pipe by means of a flexible hose, in order that the burner can easily be disengaged from the air line and withdrawn from the furnace. This is accomplished by a sliding coupling on the air connection. Fig. 3 shows the burner connected to and withdrawn from the supply pipe.

This arrangement permits of changing from coal to oil fuel, or *vice versa*, which makes it possible to burn oil during the day and coal during the night when the fires are banked.

This burner is manufactured by H. L. Albee, East Douglas, Mass.

First Monthly Meeting of the Institute

On Tuesday evening, February 9, the first of the series of regular monthly educational meetings inaugurated by the executive committeee of the Institute of Operating Engineers was held at the Engineering Societies' building, 29 West Thirty-ninth street, New York City.

Hubert E. Collins acted as chairman and after briefly outlining the objects of the institute and giving the reasons for holding the meetings, he introduced Prof. F. H. Sykes, director of Teachers College, Columbia University, who gave a half-hour talk on the necessity for industrial education as is exemplified by the scarcity of trained workers in all cases of modern industry.

Professor Sykes has made a careful study of the systems of industrial education in vogue in all the countries of Europe in which the industrial arts are most highly developed, and his address on this occasion was greatly enforced by statements of the changes in certain industries which in many cases have been wrought in a few years by the influence of the industrial schools, in some instances the school saving the industry from complete decline and the people who engaged in it from financial and industrial ruin.

He was followed by C. H. A. Bjerregaard, librarian of the Astor library, who dwelt on the ethical phases of the subject.

Mr. Jurgensen then presented a paper pointing out the weak spots in the present system of education for the engineering profession and outlining the institute's plans to provide him a balanced and competent system of professional education.

Professor Lorentzen, of New York University, in a few well chosen words emphasized what had been said by the preceding speakers.

He was followed briefly by F. L. Johnson, Timothy Healy and H. M. Elder, all of whom spoke of the significance to the operating engineer of industrial education as proposed by the institute.

San Francisco Exposition

San Francisco is to have the exposition to be held in 1915 in commemoration of the completion of the Panama canal. A joint resolution to this effect has already passed the House and is sure to pass Congress. California has promised $17,500,000 for the proposed exposition and no pecuniary aid has been asked of the national Government. New Orleans has put up a hard fight for the honor, but the location chosen will have the advantage of giving many of the visitors an opportunity to view the canal.

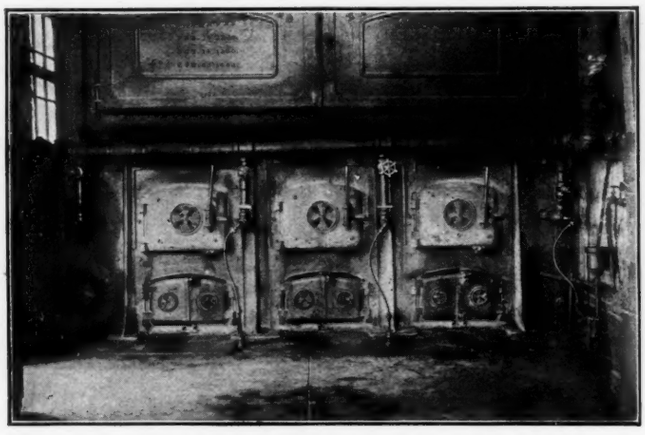


FIG. 2. BURNER IN PLACE READY TO SUPPLY OIL AS A FUEL

FIG. 3. BURNER PULLED OUT READY TO BURN COAL IN THE FURNACE

PERSONAL

Dr. F. R. Hutton, late of Columbia University and honorary secretary of the American Society of Mechanical Engineers, has been appointed consulting engineer of the Department of Water Supply, Gas and Electricity of New York City, vice George W. Birdsall, deceased.

On the evening of January 25, Melville W. Mix, president of the Dodge Manufacturing Company, celebrated the twenty-fifth anniversary of his connection with the company by giving a splendid nine-course dinner to stockholders and directors. At the close of the dinner, Mr. Mix was presented with a silver gold-lined loving cup by First Vice-

president W. B. Hosford as a token of the company's esteem and confidence.

Mr. Mix began as office man and at one time was wrapper of *Power and Transmission*, the company's official organ. He became shipping clerk and also went to New Orleans, where he assisted in the Dodge exhibit at the exposition. In 1890 he went to Chicago, where he became Chicago manager of the company. In 1894 he was returned to Mishawaka and became general manager and in 1895 he was elected president and general manager, and has occupied that position since that time.

BOOKS RECEIVED

THE SLIDE RULE. By Frank C. Hinckley and William W. Ramsay. Engineering Text Book Company, Boston, Mass. Leather; 104 pages, 4x6¾ inches. Price, $1.75.

APPLIED THERMODYNAMICS FOR ENGINEERS. By Prof. William D. Ennis. D. Van Nostrand Company, New York. Cloth; 438 pages, 6x9¼ inches; 316 illustrations; indexed. Price, $4.50.

THE DISTINGTON MULTIPLE BOILER EXPLOSION AND OTHER MULTIPLE BOILER EXPLOSIONS. By Edward G. Hiller. Taylor, Garnett, Evans & Co.. Ltd., Manchester, Eng.; 60 pages, 5½x8½ inches; illustrated; plates. Price, one shilling.

THE PRACTICAL ENGINEER ELECTRICAL POCKET BOOK. The Technical Publishing Company, London, Eng. Cloth; 567 pages, with diary additional, 3½x5½ inches; illustrated; tables; indexed. Price, one shilling and sixpence.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

INTERNAL COMBUSTION STEAM MOTOR. Edward P. Noyes, Winchester, Mass., assignor, by mesne assignments, to C. P. Power Company, Newark, N. J., a Corporation of New Jersey. 982,850.

WAVE MOTOR. Telesphore J. Beaudette, Los Angeles, Cal. 982,928.

TURBINE. William S. Elliott, Pittsburg, Penn., and Frank M. Faber, Canton, Ohio; said Faber assignor to said Elliott. 983,032.

ROTARY MOTOR. William S. Elliott, Pittsburg, Penn. 983,033.

MOTOR. William S. Elliott, Pittsburg, Penn. 983,034.

INTERNAL COMBUSTION ENGINE. Martin T. Anderson, Lakeland, Fla. 983,109.

INTERNAL COMBUSTION ENGINE. Dugald Clerk, Ewhurst, England. 983,206.

ROTARY ENGINE. Ira M. Kephart, Punxsutawney, Penn. 983,257.

BOILERS, FURNACES AND GAS PRODUCERS

LIQUID FUEL BURNER. Jefferson B. Hayden, San Angelo, Tex. 982,960.

SMOKE CONSUMER. August G. Krieg, Minneapolis, Minn. 982,970.

WATER-TUBE BOILER. Minott W. Sewall, Roselle, and David S. Jacobus, Jersey City, N. J., assignors to the Babcock & Wilcox Company, Bayonne, N. J., a Corporation of New Jersey. 983,000.

STEAM BOILER. Minott W. Sewall, Roselle, N. J., assignor to the Babcock & Wilcox Company, New York, N. Y., a Corporation of New Jersey. 983,170.

STEAM BOILER. James R. Vance, Geneva, N. Y. 983,184.

POWER PLANT AUXILIARIES AND APPLIANCES

VALVE. Rush L. Hobbs, Sumner, Ill. 982,815.

MIXING VALVE FOR HYDROCARBON ENGINES. Philip Devereux Johnston, Cold Spring, N. Y., assignor to American Oil Engine Company, a Corporation of New York. 982,825.

MIXING VALVE FOR INTERNAL COMBUSTION ENGINES. Philip Devereux Johnsion, Cold Spring, N. Y., assignor to American Oil Engine Company, a Corporation of New York. 982,826.

AUTOMATIC PUMP. Charles W. McGonigle, Seattle, Wash., assignor to Automatic Gas Pump Company, Seattle, Wash. 982,843.

ROTARY PUMP. Albert E. Stoker, Chicago, Ill. 982,895.

LUBRICATION APPARATUS. John Triftshauser, Hornell, N. Y. 982,906.

COMBINED THROTTLE VALVE AND OILER. Lewis C. Bayles, Johannesburg, Transvaal, assignor to Ingersoll-Rand Company, New York, N. Y., a Corporation of New Jersey. 982,927.

FLUE-CUTTING DEVICE. Lander B. Burt, Hallock, Minn. 982,932.

STEAM-ACTUATED WATER TRAP. Jas. E. Jones, Richmond, Ind. 982,967.

PISTON ROD. William R. McKeen, Jr., Omaha, Neb. 982,972.

VALVE GEAR FOR STATIONARY ENGINES. Charles J. Pilliod, Toledo, Ohio. 982,987.

AUTOMATIC GOVERNOR AND REVERSING GEAR. Charles J. Pilliod, Toledo, Ohio. 982,988.

LUBRICATOR. Nathaniel L. Chalmers, Newark, N. J. 983,025.

CENTRIFUGAL PUMP. John L. Heald, Alamogordo, N. M. 983,137.

STEAM-BOILER SAFETY DEVICE. Jorgen P. Jurgensen, Tarkio, Mo. 983,144.

ENGINE GOVERNOR. James McGowab, St. Louis, Mo. 983,159.

METALLIC PACKING. Martin Brussard, Seattle, Wash., assignor, by mesne assignments, to Brown Metallic Packing Company, Seattle, Wash., a Corporation of Washington. 983,201.

SUCTION PUMP. Claude R. Smith, Dayton, Ohio, assignor to Anthony L. Herkenhoff, Minster, Ohio. 983,253.

ELECTRICAL INVENTIONS AND APPLICATIONS

DYNAMO ELECTRIC MACHINE. Bernard A. Behrend and Allan B. Field, Pittsburg, Penn., assignors to Allis-Chalmers Company, a Corporation of New Jersey, and the Bullock Electric Manufacturing Company, a Corporation of Ohio. 982,784.

ELECTROMAGNETIC POWER TRANSMITTING MECHANISM. Augustus Jesse Bowie, Jr., San Francisco, Cal. 982,789.

DYNAMO ELECTRIC MACHINE. Carl J. Fechheimer, Milwaukee, Wis., assignor to Allis-Chalmers Company, a Corporation of New Jersey. 982,806.

DYNAMO ELECTRIC MACHINE. Albert Kingsbury, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 982,830.

ELECTRIC SWITCH. William T. Pringle, Philadelphia, Penn. 982,869.

ELECTRIC SIGNALING DEVICE. Donald M. Bliss, New York, N. Y. 982,930.

ELECTRIC CASH REGISTER. Joseph P. Cleal, Toronto, Ontario, Canada, assignor to the National Cash Register Company, Dayton, Ohio, a Corporation of Ohio. 982,938.

METHOD OF SUPPLYING ELECTRIC FURNACES WITH POLYPHASE CURRENTS. Paul Girod, Ugine, France. 983,043.

POWER PLANT TOOLS

WRENCH. George Washington Gruver, Monterey, Cal. 982,951.

VALVE GRINDER. Joseph Yates Porter, Jr., Knights Key, Fla. 983,084.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 3.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Commander U. T. Holmes, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., O. P. Chamberlain; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Pres., R. P. Bolton; sec., W. W. Macon, 29 West Thirty-ninth street, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

There was once a young Shepherd Boy who tended his sheep at the foot of a mountain near a dark forest. It was rather lonely for him all day, so he thought upon a plan by which he could get a little company and some excitement. He rushed down toward the village, calling out, "Wolf, Wolf!" and the villagers came out to meet him. This pleased the Boy so much that a few days afterward he tried the same trick, and again the villagers came to his help. But shortly after this a wolf actually did come out from the forest, and began to worry the sheep, and the Boy of course cried out, "Wolf, Wolf!" But this time the villagers, who had been fooled twice before, thought the Boy was again deceiving them, and nobody went to his aid. The wolf made a good meal off the Boy's flock and when the Boy complained, the wise man of the village said: "*A liar will not be believed, even when he speaks the truth.*"

While reading this one of Aesop's Fables, written some twenty-five centuries ago, we couldn't help wondering whether there was not advertising in some crude form even in those days.

The moral so exactly illustrates the reason why an advertiser who advertises regularly in reputable papers must back up his claims with bona fide goods!

And why an advertiser whose goods do not meet the claims made for them will not appear on the pages of reputable papers for any length of time.

We recently met a man who had been selling patent medicines. He told how in the last five years he had advertised and sold six different brands.

That is to say, *different* in name. The mixture was exactly the same each time, being advertised only as long as the new name and new claims would fool people into buying.

However, patent medicines and other articles which are put out to fool the public are now practically eliminated from the better grade weeklies and monthlies, and even the dailies are closing the door on them.

This change of attitude on the part of publishers is due to the ever increasing recognition of Advertising Ethics. That advertisers have come to a realization of their responsibility is shown by this report from one of our solicitors.

He says: "This concern is manufacturing a new design of gas engine. They are not yet in a position to advertise it because it has not been tested long enough to know whether it will 'stand up' or not. In fact, they refuse to make any sales until they are absolutely certain that it will be right in every particular."

In the same mail we get a letter from a subscriber, who, in renewing his subscription, says: "You may be interested to know that after reading the advertisements of the ———————— Indicator, I bought one and found it to be all they claim for it."

This is the beginning and the ending of the story of modern advertising.

It begins with the advertiser who knows it will not pay him to advertise any but tested and proved machinery—

And ends with the buyer who finds the goods "all that is claimed for them."

Back of it is a conscientious publisher who will not insert the advertisement of the man trying to pull off something in the nature of a fake deal.

The publisher may be doing it from a sense of honesty, who knows? Give him credit for it, anyway.

In any event he knows it's poor business in the long run to do anything else.

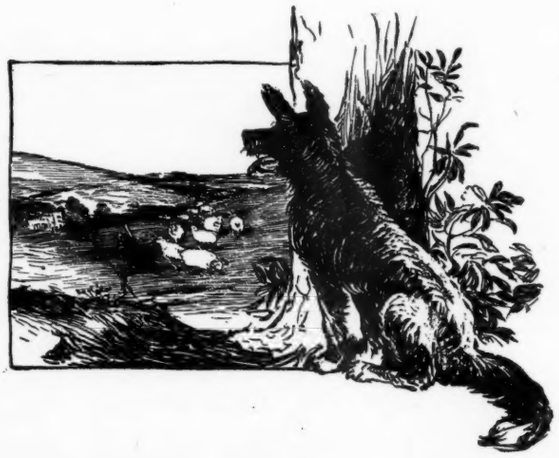
The up-to-date buyer comes pretty close to knowing who's who and what's what.

And if he happens to be a power-plant man, he knows what supplies, equipment, money- or time-saving appliances he wants.

He *knows* because he reads the advertising pages of his technical paper and sees what goods are advertised regularly for which certain claims are made, backed up by convincing "reason why" copy.

The maker of a good article *can* advertise regularly and convincingly.

The maker of an inferior one can only raise the cry of "Wolf!" until the people get used to it and no longer answer the call.



BUSINESS ITEMS

Pawling & Harnischfeger Company, Milwaukee, Wis., builder of cranes, hoists, etc., announces the opening of a branch office at 533 Baronne street, New Orleans, La., under the management of T. W. Waddell.

The Westinghouse Electric and Manufacturing Company has sold the Isthmian Canal Commission two 75-kilowatt motor-generator sets with a switchboard for the control of each. One of the motor-generator sets will be located in the substation near the site of the Gatun locks and the other on the Pacific side, near the Pedro Miguel locks. The apparatus will be used in connection with the construction of the lock gates.

At the Lardner's Point pumping station, Philadelphia, six of the first pumping engines were equipped with the ordinary type of force-feed lubricator. Later on, when six additional units were installed, these were equipped with the Richardson lubricator, and it was noted that in the second batch of engines, superior lubrication was being secured with less oil consumption. It was, therefore, decided to run a comprehensive test. A 30-day run was made on one of the first units equipped with the ordinary type of lubricator, and the same unit was then run 30 days more, equipped with the Richardson lubricator. The latter test proved that the Richardson gave equally satisfactory lubrication with one-third less oil.

NEW EQUIPMENT

A. B. Lorino, Matagorda, Tex., will install an ice plant.

Willamette, Ore., will install a complete system of waterworks.

The city of Ashdown, Ala., will construct an electric-light plant.

Battle Creek, Neb., will spend $10,000 for new waterworks system.

Spring Hill, Kan., has voted $6000 bonds for an electric-light plant.

Portage La Prairie (Man.) will install a new electric-lighting plant.

Point Pleasant, N. J., is considering plans for a municipal waterworks.

Kirkville, Mo., is contemplating the establishment of a lighting plant.

Redmond, Ore., will install a new waterworks system to cost $10,000.

Vancouver, B. C., is in the market for $10,000 worth of water meters.

The Clinton (Ky.) Water and Light Company will establish an ice plant.

The Virginia Mills, Suffolk, Va., will double the capacity of its power plant.

J. S. Lewis, Ogden, Utah, is seeking a franchise for an electric-light plant.

The Pacific Power and Light Company, Fruitville, Wis., will enlarge its plant.

The Monticello (Ark.) electric-light plant was destroyed by fire. Loss, $15,000.

Olean, N. Y., is considering the question of establishing a municipal lighting plant.

Ira Hickman, Spearville, Kan., is preparing to construct an electric-light plant.

Bonds for $60,000 for municipal waterworks have been voted at Brandon, Ore.

C. R. Wickes, Orland, Cal., has been granted franchise to erect a power plant.

It is stated the Elizabeth (N. J.) Ice Company will erect a new 150-ton ice plant.

The Edmonton (Alberta) Heat and Power Company will build a large power plant.

The Windsor Print Works, North Adams, Mass., wil install a system of motor drives.

The city of Cheney, Wash., will spend $15,000 on improvements in its water system.

The Idaho Realty and Power Company, Dixie, Idaho, will erect a hydroelectric plant.

The Bernardin Bottle Cap Company, Evansville, Ind., will install new boiler and engine.

The city council, Alabama City, Ala., has decided to construct a municipal water plant.

The city council, Humeston, Iowa, is considering the question of a new electric-light plant.

Cadillac, Mich., has authorized the purchase of new machinery for the pumping station.

Salmon City, Idaho, is contemplating to improve its water system at a cost of $10,000.

Lewiston, Mont., is contemplating the installation of a waterworks system to cost $100,000.

The Norfolk & Portsmouth Traction Company will erect a new boiler house at Suffolk, Va.

George D. Brown, Chelan Falls, Wash., will build a power plant at that place and also at Entiab.

C. C. Murray & Sons, Madisonville, Tex., have been granted a franchise for an electric-light plant.

The Cold Storage Company, Siloam Springs, Ark., has awarded contract for the construction of buildings.

The lighting plant of 101 Ranch, owned by Miller Brothers, at Bliss, Okla., was destroyed by fire.

The substation of the Southern California Edison Company, at San Pedro, Cal., was destroyed by fire.

Kansas City, Kan., will vote on the question of issuing $350,000 bonds for a municipal electric plant.

A 50-kilowatt engine and generator will be required for the new municipal building at New Bedford, Mass.

Cleveland, Ohio, contemplates the erection of a municipal light, heat and power plant. A. B. Lee, city solicitor.

The New York, New Haven & Hartford Railroad will erect an addition to its power station at Coscob, Conn.

The Lewiston-Clarkston Company, Lewiston, Idaho, is planning to install a waterworks system at Asotin, Wash.

The North Pasadena (Cal.) Land and Water Company will make extensive improvements in its water system.

The Evansville (Ind.) Pure Milk Company will erect an addition and install new boiler and refrigerating machinery.

The Olympia (Wash.) Brewing Company will erect a new building at Pasco. Refrigerating plant will be installed.

The United Gas and Electric Company, Jeffersonville, Ind., will expend $30,000 in improvements and extensions.

D. K. Barr, Louisville, Neb., will receive bids March 1 for the construction of waterworks to cost about $16,000.

Elyria, Ohio, has under consideration improvements to its waterworks system, including new pumping machinery.

The Americn Fish and Oyster Company, San Francisco, Cal., will erect a new building and install a refrigerating system.

The Sacramento & Sierra Railway Company, Sacramento, Cal., is contemplating the erection of a large plant near Placerville, Cal.

The Lexington & Interurban Railway Company, Lexington, Ky., will expend $1,000,000 in improvements, including the erection of a $500,000 power plant.

The Knightstown (Ind.) Ice Company has been incorporated with a capital of $12,000 to manufacture ice by P. W. & M. T. Gilbreath, A. A. McCray.

The Southwestern Power and Traction Company will erect a power plant at New Iberia, La., and several substations. F. W. Crosby, New Orleans, is president.

C. H. Hughes & Co., engineers, 82 Beaver street, New York, are revising their files and would like to receive catalogs of direct-connected steam engines and dynamos, also turbine units.

The Pacific Power and Light Company, Portland, Ore., is rebuilding its power plant on White river and is planning to build substations at Walla Walla, Wash., White Bluffs, North Yakima and several other places.

The United States Hygienic Ice Company, Brooklyn, N. Y., has been incorporated with $150,000 capital to manufacture and deal in artificial and natural ice. Incorporators, G. F. Martin, E. J. Forhan, H. P. Jones, New York.

NEW CATALOGS

Ajax Iron Works, Corry, Penn. Catalog. Gas and gasolene engines. Illustrated, 32 pages, 7x10 inches.

De Laval Steam Turbine Company, Trenton, N. J. Catalog. Steam turbines. Illustrated, 120 pages, 6x9 inches.

Simplex Engineering Company, 1109 Locust street, Philadelphia, Penn. Circular. Simplex pipe clamp. Illustrated.

Sprague Electric Company, 527 West Thirty-fourth street, New York. Catalog No. 436. Conduit products. Illustrated, 46 pages, 6x9 inches.

Westinghouse Electric and Manufacturing Company, Pittsburg, Penn. Booklet. "Electric Meters—How to Read Them." Illustrated, 12 pages, 3½x6 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4807. Small plant alternating-current switchboard panels. Illustrated. Bulletin No. 4810. Portable and stationary air-compressor sets. Illustrated. Bulletin No. 4804. Direct-connected generating sets. Illustrated. Bulletin No. 4685. Belt-driven alternators. Illustrated.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

WANTED—Experienced salesman to sell the Rolin patent adjustable grate bar; exclusive territory and liberal commission. Write Standard Grate Company, Heed building, Philadelphia.

ENGINEERS wanted in every town to sell Wiechmann tube cleaners for water and fire tube boilers: perfection in the art; attractive proposition. Clyde Machine Works Co., Chicago, Ill.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

SUBSTANTIAL mining company in Mexico require the services of an A-1 experienced master mechanic, thoroughly up in electrical

and mechanical engineering, and mining and milling machinery in general; give full particulars and references; salary $200. Address "L. T. C.," Box 374, POWER.

POWER PLANT engineers and mechanics everywhere will be paid liberally for information, strictly confidential, on improvements requiring new chimney, to assist us securing contract; we do the rest and you make some easy money. Address Construction Co., 1307 Manhattan Bldg., Chicago, Ill.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FIREMAN, sober, five years' experience, wishes to better himself. Box 382, POWER.

WANTED—Position by young married man, familiar with a.c. and d.c. in parallel and all makes of engines and boilers; references. Box 380, POWER.

CHIEF ENGINEER desires to change; holds position as chief engineer and master mechanic; first class Massachusetts license; strictly temperate; married; age 32. Address Box 383, POWER.

MECHANICAL ENGINEER; competent designer, mechanical, electrical and construction work; broad experience development and design of industrial plants; technically educated; age 26. Address Box 386, POWER.

YOUNG TECHNICALLY EDUCATED engineer (M. E.-E. E.), experienced in railway and central station design, construction, operation and business methods, desires position of responsibility; energetic; best references; any location. Address Box 384, POWER.

SUPERINTENDENT OR ASSISTANT of city or manufacturing company light or power plant; fifteen years' practical experience; theoretical training; thoroughly familiar with a.c. or d.c. work; best of references. Address Box 387, POWER.

WANTED—Position as chief in any kind of steam plant up to 1500 horsepower, or assistant engineer in any size plant; am sober, steady and married; first class Ohio license; go any where; first class pump man; some refrigerating experience; good references; open March 1, sooner if necessary; no night work; nothing under $75 per month considered. Address Box 376, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

AN EFFICIENT selling organization with offices in New York City, wishes to add boilers and engine room equipment to its line; only exclusive agencies considered; can show results. Address "U," Box 388, POWER.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

ELECTRICAL ENGINEERING—An opportunity to learn above trade at specially low rates; by entirely new methods we have prepared a course of instruction for $10 only, easy payments; at any rate, see what we have to say before paying more. P. O. Box 811, Cincinnati, Ohio.

I DESIRE to obtain the sales agency in the Chicago territory for some reliable manufacturer of steam engines, air compressors, pumps or similar lines; have had some years' experience and have extensive acquaintance in the trade there; a mechanical engineer with both commercial and manufacturing experience. Address Box 385, POWER.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—A $130 scholarship with International Correspondence Schools; will sacrifice for cash. E. F. Banette, St. Albans, Vt.

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., 424 Madison St., South Bend, Ind.

FOR SALE—Electric light plant in growing Nebraska town, pumping city water, new 20-year franchise and street-lighting contract. Box 381, POWER.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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Jefferson Union Co..... 9
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Anderson Co., V. D..... 98
Schutte & Koerting Co..74 and 90

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Westinghouse Machine Co....118

Furnace Door Arch
Betson Plastic Fire Brick Co. 108
Harbison-Walker Refractories Co. 107
McLeod & Henry Co.....106

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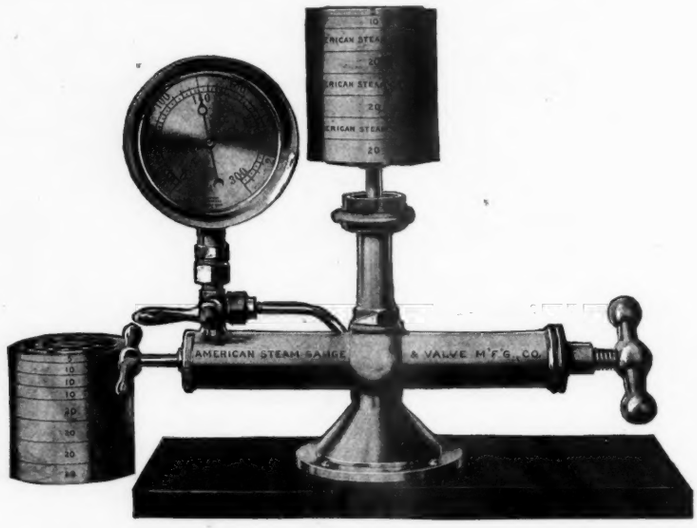

American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

New York, 26 Cortlandt St. **Atlanta, 525 Candler Bldg.** **Chicago, 130-132 Jefferson St.**
Pittsburg, Columbia Bank Bldg. **San Francisco, Monadnock Bldg.** **Montreal, 444 St. James St.**
Los Angeles, 213 So. Los Angeles St.